

# A Historical Compendium of the Palmyra Atoll's Western Lagoon: 1802 to 1958



*Palmyra's Western lagoon in November, 1935, prior to the start of Naval construction activities*

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## Introduction

The goal of this compendium is to collect and present any historical material which makes mention of Palmyra's western lagoon, and highlight significant activities related to it. Specifically, material created or published between the years 1802 and 1958. This time frame was determined to be significant, as it covers, respectively, the period between Palmyra's first documented visit by westerners, and the broad, institutional acknowledgment of the severity of Palmyra's ecological destruction, at the hands of the US Government.

The material collected is extensive in scope, relative to the amount of historical material available on Palmyra. However, the author fully acknowledges that it excludes material from a number of historically significant events, studies, descriptions, etc. This was done intentionally, in an effort to maintain a focus on the narrative of the western lagoon, and its changes over time.

### Structure of Material

In the interest of communicating the material in a clear narrative structure, which also lent itself to readability as a research aid, the content is organized into three distinct sections:

The *General Historical Mentions* section collects specific written accounts related to the lagoon and those people who visited, lived, and worked in and around it. These are presented in chronological order and include a wide range of sources, such as ship's logs, newspaper articles, scientific journals, and government sponsored reports, to name a few. In some cases, the content has been slightly modified to improve readability, or transcribed as accurately as possible, but minor errors or omissions may be present. Some of the material is representative of its historical setting, and presented as it was originally written or intended, to preserve as much accuracy as possible.

For ease of use, material that is underlined indicates a direct mention of the western lagoon or its features. The material before and after this is included to help contextualize the content and offer additional insight into the events or descriptions.

The *Naval Construction History* section offers a summarized narrative of the large-scale construction activities that took place between 1939 and 1945. The focus is placed on the physical changes of the atoll, the processes by which those changes were undertaken, and any materials introduced by the work and Naval occupation of Palmyra, both during and after the construction works projects were finished.

Sources for the material used to develop this summary is listed in the Appendix subsection, *Naval Construction Sources*. This subsection also includes relevant excerpts from those sources. Readers interested in learning more about the construction projects and Naval occupation of Palmyra, should benefit from reviewing this material.

The *Appendix* offers materials which, while not essential for an understanding of the lagoon's history, should give insight into the documents and their descriptions of the lagoon. These

include a list of all fauna mentioned throughout the historical material, with a table highlighting mentions of Ulua and their recorded sizes, the aforementioned Naval construction sources and excerpts, and descriptions of events or cultural trends mentioned in the compendium, to help contextualize the setting and significance of material.

## Acknowledgements



*Botanist Joseph F. Rock aboard the Luka, anchored off Palmyra, 1913*



*Botanist E. Yale Dawson examining algae specimens on Palmyra, 1958*



*Bruce Halstead, M.D., collecting fish on Palmyra, 1958*

Any historical study of Palmyra, especially as it relates to the flora and fauna of its land and lagoons, owes a tremendous debt to the work of a small group of scientists and explorers (three of which are pictured above). They saw the beauty and intrinsic value of Palmyra, where others saw only the potential for profit and raw resource. They lived and worked on the atoll in primitive and difficult conditions, with little promise of recognition, preserving and documenting the vast array of life represented, and the environments as a whole.

The reports, journal articles, and studies they produced (many of which are included in this compendium), present living descriptions of Palmyra. I am personally grateful for their hard work and sacrifice in representing such a special place, and ensuring future generations would know its story.

The author also wishes to express his deepest gratitude to the following institutions and their support staff, for their commitment to preserving historical records in all their forms, and for the time they took to share that history with me, so it could be included in this compendium (especially considering the public health crisis that arose during the work).

Smithsonian Institution Archives

National Archives at San Francisco

The National Archives, United Kingdom

Loma Linda University

Bishop Museum Archives

United States Fish and Wildlife Service

The Nature Conservancy

## **General Historical Mentions**

### **Part 1: 1802 - 1935**

#### **Visit by American Ship Palmyra**

**Date:** November 10th, 1802

**Summary:** Cornelius Sowle, captain of the ship Palmyra (where the atoll gets its name), was the first westerner to go ashore and document a description of the lagoon and its interior features.

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*The following is from a letter written by Captain Sowle.<sup>1</sup>*

“PALMYRA ISLAND is situated in lat. 5° 49' N. and in long. 162° 23' W. from London; it is about three leagues in extent; there are two lagoons on it; in the westernmost of which is twenty fathom water, with a fine sandy bottom. It is very dangerous to approach the western part of the island, on account of the coral rocks which are just below the surface of the water, and extend to the distance of three or four leagues from the shore. The eastern part terminates in a steep reef of coral, over which the sea breaks with considerable force.

CORRECT RELATION OF SHIPWRECKS. On the north-west side there is good anchoring ground, about three quarters of a mile from the breakers, in eighteen fathom water, on a coral bottom. There are no inhabitants on the island; nor was any fresh water found; but cocoanuts of very large size are in great abundance; and fish of various kinds, and in large shoals, surrounded the land. A great quantity of driftwood lay on the beach, which enabled those who landed to ascertain that the rise of the tide was about eighteen inches.”

#### **Visit by American brig Brothers**

**Date:** June 25th, 1810

**Summary:** The brig Brothers was hired by Captain Edmund Fanning of England, to search various Pacific islands and atolls for resources such as Beach le mar (sea cucumber), coconuts, and guano.

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*Excerpt from the journal of Captain Donald MacKay<sup>2</sup>*

Monday 25th

Unfriendly breezes at Northeast and squally weather. At 2:15PM once more saw the Islands of Palmyra, bearing by compass West Northwest about 4 leagues distant.

At 4PM the weather thick and squally, the wind far to the North, would not risk anchoring in this situation the bank being on the weather part of the Island, no time for sending a boat on shore, hove to off to the South and East. We must have had an astonishing weather current since leaving Fanning Island and ??? in our absence from this Island - Our distance East of this Island on Thursday 21 (by calculation) was about 20' since which time the log gives about 132' West.

At 6AM the Island bore Northwest and West 4 leagues distant. At half past I set out in the whale boat for the shore - landed on the eastern part without difficulty and proceeded to examine the reefs for Beach la mar. The schooner standing aft and on to the windward of the land

Tuesday 26th

At 4:30 return'd on board having examined the island as far as I could in the time that I was on shore. Found the black kind of Beach la mar (on the article we have taken for it) in considerable quantity, but very small. Saw no appearance of an inlet to the lagoon sufficient to admit a vessel. I was unable to go into the western part of the lagoon with the boat from the reefs that extend across it. I walked on shore as far as the time would admit and saw what appeared to be a low sand bar forming the western side of the land. The walking was intolerably bad (so) that it would have made it night before my excursion was over, had I went to determine it.

I therefore got a few turtles and cocoanuts and returned on board, intending to run down to the Southwest part of the land and send a boat to examine the West end, and get some more turtle, fish, or coconuts.

...

This is the last land I ever set foot on, and with great deference to the discoverers, I shall call it a reef with trees on it; being about 4 leagues in circumference - much longer from East to West than North to South it affords cocoanuts, turtles, and fish, has two lagoons, that in the Western

part deep and intersected like those of Chifton and Fanning Islands, with numerous reefs of coral banks. The eastern one is shoal and rocky, boats may enter at either end of a small stony beach which forms the Eastern part of the Island and thence may pass (at high water) into the other lagoon. There is a coral bank marker off to the East (or Northeast) about 1/2 a league, on which is prom to 18 fathoms water. We found it too rough to anchor on it, a large sea heaving in directly on shore, and the wind most of the time from the same direction.

Of the western part I know nothing.

I found many parts of the shore strewn with charcoal, which our blacksmith (who was with me in my excursion) said was excellent coal, and doubtlessly burn'd for the smith use.

There was a very large white oak tree on the beach which appeared sound, and as if it has been but a short time from its native soil, no barnacles on it and very little eaten by the worms. The bark smells as fresh as if it had been lately cut.

Therefore that the situation of this reef as stated in my instructions is correct, notwithstanding our run from Fannings Island not agreeing with the longitude of it. My Lunar observation of the 24th comes but little from it. From this state my departure, supposing it at Meridian to bear due North 2 leagues distant.

## Visit by Brig Fairy

**Date:** July 21st, 1848

**Summary:** Under the command of Captain Edward Lucett, the Fairy sailed from nearby Fanning Island to search Palmyra for the wreck of a recently lost ship.

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*Excerpt from an account by Edward Lucett<sup>3</sup>*

“Palmyra Island was in sight this morning, but in consequence of a calm, it was late in the afternoon before we effected a landing. We spent the two following days in search of the vessel reported to have been cast away here, but no signs of it exist, nor does the island appear to have

ever before been visited by the foot of man. It is, without exception, the most singular formation I have seen. We landed on the east side, the vessel having suddenly shoaled her water when about two miles from the breakers observed upon the land. We hove to in six fathoms; bottom white sand and coral. A ridge of breakers extends half a mile from the south-east point of the island, and a similar one runs off the north-east point, which help to form a concave crescent, within which the water was placid; but the island itself elicited our astonishment. We landed without difficulty on a flat contained between the two curving points of breakers, which had on it barely sufficient depth of water for us to track the boat a quarter of a mile, when we reached an islet, with its luxuriant foliage growing apparently from the very surface of the water; and we then discovered that Palmyra Island is more properly an archipelago of islets. A rocky flat, from six to eight miles in circumference, is covered, with water from ankle to knee-deep, save where it is studded with islets placed indiscriminately. The islets rise only a few feet above the level of the water, and are composed of grey crystal rock, with a super-surface of rich black mould, yielding a rank growth of grass, vines, and trees common to the tropics, the cocoanut and pandanus being amongst them. Some of the islets appear exclusively appropriated to the cocoanut tree ; on others, a strong parasitical vine, with broad deep green leaves, has overrun the pandanus and other trees, and enshrouded them in its own peculiar livery; and when at a distance, it is hard to persuade yourself you are not surveying the ruins of buildings.

On one of the eastern islets a remarkable tree stood distinct from the others like an obelisk. So regularly had the outline been formed from the base to the summit, by the close investiture of the smoothly overlapping leaves of the vine, that we believed it to be a monument raised by the wrecked people, until by landing we convinced ourselves to the contrary. Birds and fish alike were unscared at the presence of man; and, fairly or unfairly, I pursued one fish in the shoal water till I run him aground. Sharks were numerous, and so voracious that they attacked both the boat and the steering oar as we were pulling ashore. Birds were innumerable: and it being the season of incubation, I never witnessed such a scene in my life. You could not move your foot without crushing eggs; and the cries of the birds as they arose just above your head, and darkened the air, were deafening, and more peculiar than any combination of sounds I ever listened to. Green water extends off the south side of the island between two and three miles, and a distinct line of breakers runs from the south-west point about three quarters of a mile. A vessel might anchor in the bight on the south by west side, but she would have to warp into a berth, as sunken patches of rock lie scattered about with very little water on them : they were observed from aloft, but the sea was so smooth and still that they were unnoticed from the deck. On the

west and north sides, the appearance is more that of one of the Paumutu Isles; the surf breaks on a strip of white sand, above which springs the green foliage. That we might have nothing to reproach ourselves with, we sent out thirteen volunteers to scour the island in search of any vestige of the wreck; they returned next day to the vessel, having seen no sign of man or his works. They reported occasional chasms of deep water on the shoal flat, and brought us off two green turtle; and by the tracks they conceived the latter were numerous. From a series of observations, we made the island to be in latitude 5° 51' N., longitude 162° 10' W.; the chart places it 20' further to the westward."

## Visit by brig Josephine

**Date:** October 19th, 1859

**Summary:** The Josephine was dispatched by order of King Kamehameha IV, to help establish commercial rights on Palmyra.

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### *Excerpt from the Journals of Gerrit P Judd<sup>4</sup>*

"Wednesday, Oct. 19: At 6 A.M. Land was discovered on the Lee bow - by breakfast time saw Cocoanut trees, scattering. Anchored about 9-1/2. Charles went ashore, landed Dr. Drysdale's and the Tent. Came back in a squall, which frightened me. Our men caught a quantity of fish & Sharks. At 12 dined & went ashore. It is 4 or 6 miles. The natives come in the Brig's Boat. Water grows shallow until it grounds the boat - then deep water and we land where the trees grow, not more than 2 ft. above the water. Charles went off in the whaleboat exploring. The Dr. & I take the other boat & do the same. Reached the shore, after sailing 5 miles. Charles went to the North. I waited the arrival of the Schooner's Boat & with Dr. D. went to the Westward. We visited 4 Islets & found nothing. I then advised the Dr. to examine the 2 others & I would wait for him. He returned, reported that he had visited 2 & found 10 or 12 cargoes of Guano. Tide failing as we left the boat & went to Camp. Found Charley had left his boat & come in on foot, with a fine specimen of Guano. Capt. Stone also came, altogether 25 persons.

Thursday, Oct. 20: After breakfast with Charley, Dr. Drysdale & a Boat's crew went and examined the deposit 100 feet in diameter & circular, 1 foot deep. Visited other Islands of which

there are 30 or 40 in the circumference of the Lagoon. Waded knee deep, found no new deposit equal to this, & Dr. D. saw a tree had been cut down for the nuts & another with initials which we could not make out. Old Pine Log 6 x 4 feet, 2 of them.

Came on board at 12 with a high wind & smooth sea, after leaving a bottle containing notice of taking possession. The Brig's Boat came later with the natives & at 3 P.M. we were under way for Honolulu."

### **Visit by Schooner Louisa**

**Date:** April 15, 1862

**Summary:** On behalf of Prince L. Kamehameha, Zenas Bent visited Palmyra aboard the Louisa, claiming formal possession of Palmyra for the Hawaiian Kingdom.

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*Excerpt from a letter written by Zenas Bent to Prince L. Kamehameha, Minister of the Interior<sup>5</sup>*

The island is about ten miles in length and six miles in breath. The eastern end rises about twenty feet above the level of the sea. The landing is on the west end; and a vessel can lie in perfect safety in three fathoms of water.

The trees on the island are cocoanut, puhala and a species of the koa. All kinds of vegetables will grow on the island. I planted some beans, corn and watermelons. I erected a dwelling house on the island, and also a curing house for biche de mer.

I left on the island one white man and four Hawaiians, who are engaged in curing the biche de mer.

### **Visit by the HMS Cormorant**

**Date:** May 28th, 1889

**Summary:** The Cormorant was dispatched to Palmyra by the British Government, to formally claim the atoll for England. Despite various claims of ownership from private parties and the Hawaiian kingdom, charts at the time were often confusing or out of date, so England believed they could push a formal claim, and take advantage of Palmyra's location for use as a telegraph cable station.

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*Excerpts from ships report by Commander J.E.T. Nicolls<sup>6</sup>*

Passing the east end of Palmyra, the ship grazed a coral head; details of which are attached. Not liking the appearance of the anchorage at Palmyra (detailed report), I left the ship cruising on and off while I landed, and hoisted the flag. This was done on the little islet, on which Observation Spot is marked in the chart, where there was a flagstaff, which had apparently been erected by some shipwrecked crew. I visited Strawn Island where the shipwrecked crews generally take refuge, but could find no sign of any recent visitation.

With reference to the instructions to leave proofs of hoisting the flag, I left a notice board to that effect (copy enclosed) nailed to the flagstaff on Observation Island. I also had a declaration of Protectorate written out, and placed in a tin case; intending to leave that with a Union Jack in one of the huts, but the only hut I came across was in such a very ruinous condition, that I thought there was no good in so doing (see remarks).

## Visit by USS Portsmouth

**Date:** December 13th, 1873

**Summary:** The Portsmouth visited Palmyra as part of the United States North Pacific surveying expedition, to map uncharted or little-known islands in the Pacific. While on Palmyra, the crew performed what is considered the first extensive survey of plant and animal life on the atoll, as well as the first detailed mapping of its physical features.

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*Excerpt from the journal of William H. Jones<sup>7</sup>*

Dec 14/73: The ship anchored off Palmyra Island on Dec 14 1873, and remained until the 27th. During our stay there we collected about forty different species of fish, many of the smaller varieties from the lagoons and shallow water of the shore platform, the remainder outside the reef, around where the ship was anchored. The fish exist in the greatest abundance and many varieties are excellent eating. I do not suppose that one half the species existing in the waters around the island and in the lagoons are represented in the collection, but all were processed that our facilities for preserving and catching enabled us to get in the time we had to devote to the subject. Many species were occasionally seen which are not represented and we heard of others, but so difficult to obtain that it requires special methods to secure their capture.

One cuttlefish (octopus)\* was obtained, eight and ten species of crustacea, seven species of (echini), one of (osteria), one of (solaster), one (ophirian), five species of (holothurians), one of synapta, many species of mullusca, and shells of ten or eleven species of corals.

Palmyra is purely a coral island. It consists of fifty-eight small islets arranged in the form of an elongated horseshoe open to the westward and inclosing from separate lagoons. The islets are separated by narrow channels, through which the water has free access to the lagoons. At low water a (broad) interior shore platform of fine coral sand extends from one side of the island to the other and forms distinct boundaries for the lagoons and connects most of the islets together. It forms a barrier which is almost dry at low water, which connects the two westernmost ends of the island, there being no lagoon outlet except over it at high water. The outer shore platform is almost three hundred yards wide and is covered with coarse coral debris. From the northern and southern ends of the horseshoe, the water breaks for a mile or more and from the southern end it shoals around in a curve to the southward three or four miles from?. The island presents very scanty evidence of any other agencies having been at work in its formation, except the coral (insect) and action of the waves.

The highest point is only seven feet high. In no place has the reef rock been upheaved ? an elevation of a few inches might be (supposed) from the rock of beach formation, which in places has been raised into a horizontal position beyond the reach of the tides and shores the (evasive) action of the waves upon the old rocks, (undermining) them in places, and leaving exposed shells of ? embedded in the places where they originally grew. Some of the shells thus exposed were in a comparatively good state of representation while others were so much decomposed that they

were destroyed in the attempts to remove them. The place where this condition of things was formed is on of the eastern islets, and where the outer shore platform is almost dry at low water and only covered by a few inches at high tide while the excavations in the old rocks are at least two or two and a half feet above the level of high water at the greatest time.

The islets to the eastward were probably the first formed. On these the vegetation is dense and ?, more (genera) are represented and the cocoanut trees are more numerous and older. The island is thickly covered with vegetation but the number of species is few.

Of forest trees, there are the cocoa nut *cocos nucifera*\* *pandanus* or ?, *Pandanus odoratissimus*\* a species of *Boerhavia*, the banyan tree, and two others not determined but called in the Tahitian language the "tehemer" and "rawa".

Of the herbs there are a species of muscling *Portulaca*\* a paper grass *sefidium*\* a species of *amolulacea*\* of the genus *spomea* and two other herbs not determined.

On the islets to the north east the *Spomea* covers the ground like a carpet and completely shrouds the trees. It seems to grow in the greatest abundance where the ground is composed of nothing but coral debris. There are also a species of grass and two ferns of the genus *Ashlenium* and *Poloprudium*. The *ashlenium* forms a dense undergrowth on the islets to the eastward. Three other families of cuptogamous vegetation, misc fungi and lichens are represented.

The largest number of genera are represented on the windward islets. Here it seems the (germs) of vegetable life are first caught and afterward diffused to the westward.

There are seven large logs of Oregon red wood laying up along the shores of the islands most of them within the lagoon enclosure on the weather side. They are from five to ten feet long and from four to five feet in diameter.

We arrived at the island in the breeding season of the birds. The genus *sola* is largely represented. There are three species of this genus, one booby and two gannets. The former makes a nest of grass on the ground, the latter builds a very rude nest of twigs on the bushes and small trees. The boobies were just laying their eggs, while the garmets had theirs all hatched and the trees where white with their young.

The larger part of the birds belong to the tern family (sterna). Of the sooty tern or muddies there are two species. The larger builds its nest on the cocoanut trees at the base of the leaves, the smaller makes a nest of twigs in the forks of the other trees. There is a little white tern which lays its eggs on the naked branches of the trees. The guano or mutton bird (sluma) are very numerous. They make no nest but lay their eggs on the bare (clinker) or coral beach. They herd together in such numbers that it is difficult to walk without treading on their eggs. When they rise they darken the sun and their noise deadens the roar of the surf.

Their breeding place is on the extreme eastern islets. The other birds are the frigate bird or man of war hawk (sachyfretes aquila) the curlew, the golden backed ? and two species of snipe. The lufric bird (Phaetora) is sometimes seen but he is only a visitor.

A few spiders of large size were found on the island. They are quite harmless. Several small lizards and lizard eggs were also found.

The island is inhabited by one American and eight natives (male and female) from Tahiti, who are employed in collecting cocoa nuts to make cobrac or kobrac for exportation. The island is not very productive at present but may become so in time after all the islets are planted with the cocoanut tree.

There is no fresh water on the island, and those living there have to depend on what they collect from the rains for their subsistence. This is apparently an easy task as it rains nearly every day and the only provision made for collecting water is a large iron kettle, set under a cocoanut tree, which is kept full by the dripping from the leaves.

*Excerpt from a newspaper article in the Carlisle Weekly Herald<sup>8</sup>*

You will find this letter contains little else than a brief description of the small islands which we visited, on our recent cruise. I shall endeavor, as best I can, to give you my impressions of them, and the many curious sights and things I saw.

Palmyra Island, misplaced on the charts, consists of a cluster of small islands, some sixty in number, surrounded by a coral reef; in fact the whole island is of coral. The group forms a

horseshoe, the opening to the south and West. The reef extends about three miles to the westward of the island, and has from six to fifty feet of water on it. We anchored on the reef, to leeward of the island, established a camp on shore, and began to survey. The islands are separated by narrow channels of water, of no great depth, so that we used to wade from one to the other. Inside of the “horseshoe” are three lagoons, varying in size, separated by coral barriers. We could walk, or rather wade, across from the northern side to the souther, and thus avoid going around.

The cocoa palm flourishes on these islands, requiring no sort of care or cultivation. The nut falls from the tree, and after lying awhile ends roots down through the husk, and a top pierces it above, and thus in a few years a bearing tree is produced. Here were found, also, an abundance of curlew, and several of our party had fine sport, bagging quantities of them. Birds' eggs were very plenty; indeed, on one island, they lay so thick on the ground, that one could not walk without crushing numbers of them under foot; and when the birds were chased up, the flocks darkened the sky. The eggs were about the size of a hen's, but not quite so good eating, and a small bird, about the size of a pigeon, produced them. Besides, we found the eggs of gannets, or Solan geese, and of boobies, which birds were around and about the island in thousands. Then we saw the “frigate birds,” or men-of-war hawks, which do not fish themselves, but watch other birds taking fish home to their young, when they pounce upon them, and make them drop their prey; then they swiftly dart downward and catch the falling fishes before it reaches the water. I have watched them dozens of times, at the trick, and never once have they failed in catching their booty. The most beautiful of all, was a tropical bird of pure white, with two long pointed feathers in the tail; the older ones have a deep scarlet feather.

On some of the islands these birds are so tame and numerous, that one can pull their tail feathers out while on their nests. We found here, too, the hermit crab, or “solider crab”, which carries its house about with it; and when it grows too big for the old home, it goes to the beach and selects another domicile, and immediately proceeds to drive out or eat the animal occupying it out; then it calmly takes possession and walks off with its new shelter on its back. It is a funny and strange sight to see these fellows climbing the trees with their shells on their backs. I noticed several species of crabs, among them the “fiddler” crab and a small land crab, but the greatest crab of all was a large land crab; the body the size of a lobster, and claws in proportion. At one chop one of the side-walkers could readily take off a man's hand. These crabs climb the coconut trees and will cut down the nut, then crawl down and strip off the husk and eat the nut by some means. The

yarn goes that they will carry up the husked nut to the top of a tree and drop it on a rock, and thus break the nut and eat it. I have seen them up a tree, and have seen them stripping a nut of its husk, but I never saw them carrying one up a tree.

There are curious eels which infest the rocks on the reef, and which act more like snakes than fish. At our approach they would run under rocks, stick out their heads, open their mouths and show fight. The specimens of coral we obtained were very fine, and many beautiful varieties were picked up. Fish were plentiful. We had an abundance, in all styles and of every kind; but they did not compare with those we caught at Christmas Island, which I will tell hereafter.

We could not get any vegetables, as there were only four men, with their wives and children, on the island gathering coconuts for exportation; one white man and three natives.

*Excerpt of species from the official expedition report<sup>9</sup>*

*Tetrodon implusus*

Locality: Palmyra and Christmas Islands.

Specimens large, and sparsely spinous. Round bluish-white spots on the dorsal regions numerous, and the longitudinal lines on the under surface indistinct.

*Pseudoscaevus jonesi*

Jaws greenish; lips very narrow, covering only the base of the jaws. Two series of scales on the cheeks; seven scales in the lower series; the lower preopercular limb entirely naked. Upper profile of the head convex, not gibbous. In one specimen there is a short tooth on each side at the angle of the lower jaw, but it is absent in all the rest (three). Caudal lobes slightly produced.

Fourteen rays in the pectoral fin.

Color (in spirits) greenish-olive, yellowish about the mouth. A broad irregularly-outlined band across the snout, and from its extremities there passes backward a prolongation which touches the anterior margin of the orbit, and then passes along the superior border of the eye to the posterior part of the interorbital space, where it joins with its fellow of the opposite side, inclosing an irregularly-shaped triangular space on the front of the interocular region. Frequently (in smaller specimens) there is a narrow dark streak from the superior border of the orbit toward the middle of the interorbital space; this streak is sometimes reduced to rounded spots in the

same situation j a short streak from the middle of the posterior margin of the eye; a band below the eye, commencing near its anterior edge, and prolonged beyond the posterior margin.

Frequently two ocelli, one on either side, in front of the band on the snout, and also one behind and above the angle of the mouth; a very narrow band around the margin of the upper lip ; a broad band around the lower jaw, the two halves of which scarcely meet below in the median line; it broadens above, just below the angle of the mouth, where it is directed backward; it frequently arches downward and back- ward in this situation. It coalesces with the narrow supramaxillary band, and in some instances a narrow band passes from it to the band across the snout. Occasionally there is an ocellus on the lower jaw, behind the marginal band. Dorsal and anal fins with a narrow band along the margin, and with one or two rows of intermarginal spots. Frequently (in young specimens) these spots are confluent transversely or longitudinally, forming either vertical streaks or longitudinal bands.

Caudal with reticulating transverse bands.

Lengths, II, 12, 11 inches.

Locality: Palmyra Island.

To William H. Jones, M. D., Surgeon, U. S. 1ST., an indefatigable collector in natural history, and to whose zeal we are chiefly indebted for this collection, I dedicate this species, in remembrance of pleasant hours passed together as co-laborers, and as messmates.

*Glyphisodon septemfasciatus*

Scales between the eyes do not reach as far forward as the anterior border of the orbit. Seven transverse bands on the side of the body, broader than the spaces between them; the first and second band situated in front of the commencement of the spinous dorsal fin; third, fourth, and fifth bands under the spinous dorsal; sixth under the soft dorsal; seventh on the caudal peduncle behind the dorsal and anal fins. Upper half of the spinous dorsal blackish; caudal lobes tipped with black.

Locality: Palmyra Island.

*Chcctodon sordidus*

*Glyphisodon sordidus*

*Glyphidodon isrsodu*

Scales between the eyes extend forward to the anterior border of the orbit. Six cross-bands on the body. A large round black spot above on the caudal peduncle, behind the dorsal fin.

Locality: Palmyra Island. Found in company with *G. septemfasciatus*.

*Muraena picta*

*Gymnothorax pictus*

*Murcenophis pantherina*

*Muraena variagata*

*Murosna lita*

*Muraena sidera*

*Mureena pfeifferi*

*Sidera pfeifferi*

*Siderapanterina*

*Gymnothorax pantherinus*

Locality: Palmyra Island.

The collection contains many specimens, illustrating all the variations of color-markings of this variable species. All the teeth, except the anterior mandibulary, are uniserial in their arrangement. One specimen, six inches long, presents all the details of coloration of *Murcenatlyapaopohmbut* differs from it in its dentition.

## Visit by steamer CR Bishop

**Date:** March 23rd, 1893

**Summary:** The Bishop visited Palmyra as part of the search for the wreckage and survivors of the Lady Lampson, which was reportedly in the area of Palmyra when it was lost.

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*Excerpt from a newspaper article in the Hawaiian Gazette<sup>10</sup>*

From a distance, Palmyra Island looks very inviting and its presentation as a spot of terra firma in the midst of the vast waste of the waters makes its presence, as the least, very interesting. We

viewed the ever-changing shape of the land as we neared it, and anxious eyes were engaged in searching for a spot on the side presented which was devoid of breakers and which would afford suitable landing. Suddenly, however, our attention was drawn nearer to ourselves by the sudden formation and almost bursting in full force of a monster breaker which had without the slightest warning reared its threatening, dangerous head, upon our port quarters.

A look over the side was indulged in while the cautious and careful Capt. Le Claire was backing out for less troublous quarters and, Holy Moses, what a sight! There, seemingly packed in, wedged in in fact, were, not tens, nor hundreds, but thousands of sharks, their dark forms plainly illumined against the white coral of the bottom and contact with which would have been had we gone a ship's length further. And if we had struck and heeled to port or starboard into deeper water, just think of the possible and most probably result? A picnic undoubtedly for some few of the assembled pirates of the deep, and a hopeless search in the near future for the Bishop and her passengers. It was not a pleasant feeling that predominated in our various systems as we came in closer to the shore on the southern side of the island and saw between us and the proposed landing point innumerable fins flashing above the water.

But go, we must, and the boat being lowered a scouting party of three took passage for the distant beach. Landing had to be made through the surf, and as we rode the inward breaker our earnest hopes was that, if we spilled it would be in shallow water and away from sharks. Landing was safely made and a rapid but searching survey was made of the combination of islets which compose the island for indications of human inhabitant, but none was found. Return was made to the shore again way being made along the edge of the shallows of the deeper lagoon and even here, in two feet of water, young sharks darted at such a panic and dread, by their boldness, that a constant splashing was kept up even when in very shallow water.

The trees along the banks and in shore were loaded with the nests of goonies, boobies, man of war hawks and other sea fowl. Great flocks of birds circled overhead; their discordant cries awakening the echoes of the recesses of the tangled cocoanut jungles which flourished on every islet, while a constant watch had to be kept to avoid a sudden contact with a lumbering gooney frightened from its nest. The boat being reached then our troubles commend anew, for launching and pulling through the surf was altogether different to coming inshore on the crest of a willing breaker.

The Hawaiians with us were most nervous of the sharks and made more so as they saw hanging over the side of the Bishop a half a dozen bodies of captured man eaters from five to seven feet in length, and as a consequence had no wish to wade much in deep water. But it was necessary to go and we three whites, the chief officer, chief engineer and the writer had to lead. After two hours hard labor, being buffeted by the breakers, jammed and struck by the boat and oars, and filled with salt water the boat left the inhospitable beach of Palmyra Island and after cutting off the tops of a half a dozen breakers she floated half filled with water in the smoother sea and we were soon alongside our safer floating home.

## Visit by the Ebon

**Date:** August, 1893

**Summary:** John Cameron visited Palmyra as part of his adventure cruise through the South Pacific, and included a detailed account of his time on Palmyra in an autobiographical book.

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### *Excerpt from John Cameron's autobiography<sup>11</sup>*

Palmyra we found to be a ring of coconut-crowned islets inclosing a lagoon of fair size. Sea birds abounded, especially boatswains, they of pure white bodies and scarlet marlinspike tails, and boobies, the sleepiest and most stupid of sea fowl. Turtles were few but of gigantic size. They served, for the first time, I suppose, in all history, as steeds. With the Ughter men of the crew acting as jockeys.

We held turtle races, which were lacking in bursts of speed, though not of laughter. Who would not have roared at the clumsy creatures hoisting and humping themselves along? Two great catches we made at Palmyra. One was a diamond, or ray, fish that took a small baited line I had left hanging over the Ebon's rail. At first, not knowing what I had, I tried in vain to start the dead weight. Now and then I might gain a few inches; then a load, seemingly of a ton, would settle upon the line; yet all the time there was no struggle, nothing more than a dull, incredible sagging. For two and one-half hours I played the giant most carefully, for it could easily have snapped my line had it made a rush.

Finally I had a glimpse of a ray's dark form. In went a harpoon; the fish, struck in a vital spot, hung limp ; and with the whole crew mustered we pulled it aboard. Its mouth was fourteen inches long by four wide; the tail was six and one-half feet long; from tip to tip of the wings the fish measured sixteen feet. Its weight I had no means of determining; but the muscle required to hoist it indicated that a ton was a conservative estimate.

Our other capture was a huge shark, the largest we caught on the entire cruise, twenty-two feet and eight inches in length by eight and one-half feet in girth amidships. When dried the fins and tail weighed twenty-five pounds, the liver yielded fourteen gallons of excellent oil, enough to fill the last of our containers. In its stomach was the body of a shark we had killed the day before, itself no less than eight feet long.

Shall I tell, too, of the coconut crabs of Palmyra. They existed by the hundreds, those mammoths, those titan clawed crustaceans. As their name indicates, they live on coconuts: they climb the palms, nip off a nut, scramble down to retrieve it, strip away its dense husk, insert a claw into the soft eye of the shell, snap it open, and devour the meat. We found the animals' flesh delicious, yet it might be dearly bought, for one crab cut a man's thumb to the bone, and we freed our unhappy shipmate only by smashing the crab's claw between two stones.

At Palmyra we had good luck shark-fishing, but we worked under handicaps. Among them was the shallow water near the island, which prevented us from landing and burying the carcasses of sharks as we had done elsewhere. When we dumped the bodies overboard we were, of course, militating against our own fishing, for the remaining sharks would be less disposed to take our bait so long as they could feast on their erstwhile playmates. Horrible cannibals, those fellows! More than once a hooked shark was bitten in two before we could land him.

## Visit by the HMS Penguin

**Date:** May 21st, 1897

**Summary:** The Penguin, captained by Arthur Mostyn Field, visited Palmyra as part of a four-year survey in the South Pacific on behalf of the British Government. While primarily tasked

with improving navigational charts, a detailed inspection of Palmyra was done, to evaluate it as a possible telegraph cable station.

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*Journal of Admiral Arthur Mostyn Field<sup>12</sup>*

Landing here is something shocking. For nearly a mile the boat is twisting & turning about to avoid Coral reefs separated by deep water but so close together that a skiff can hardly get room to go between them. It is about a 2-hour job to land! Yesterday I had a long day on shore, sight & magnetism work, and each evening I have been so utterly done up that I have had to go to bed at once after dinner. But it was only Thursday evening that I had a real threatening of a headache. I can't stand this reef work & observing in a hot sun as I used to, that is quite evident. I am giving myself a holiday on board tomorrow to review all my observations but I shall have 2 or 3 more hard days this week. The triangulation of the plan of the anchorage was done the first day & already a day's sounding has been got in. So I am very well pleased on the whole.

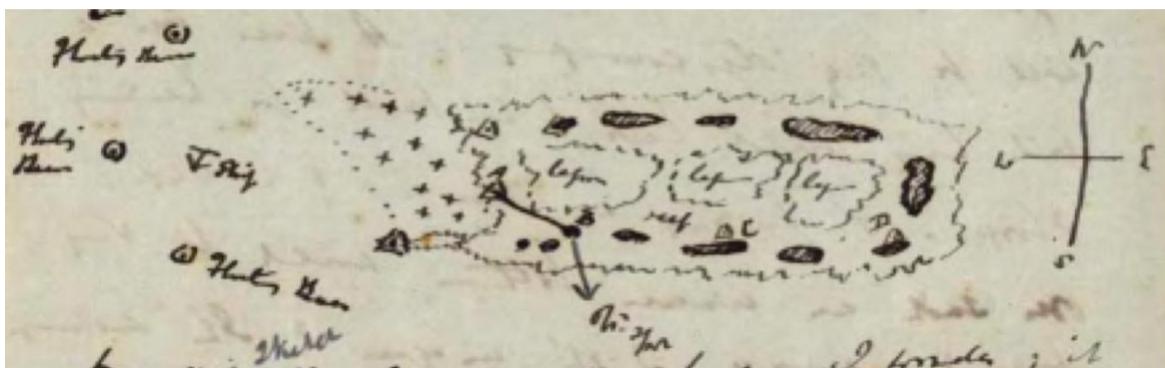


Figure A.

Does this sketch convey anything to you I wonder (see figure A); it shews approximately on scale of  $\frac{1}{2}$  inch to the mile what we are doing. The  $\Delta$ 's indicate the theodolite Stations, and A B is the base I measure along the reef. We are anchored off the west end of the island. It is really a mass of small islets as you will see standing on a reef with 3 lagoons. The whole of its western end and the anchorage is being drawn on a large-scale plan & that is now well in hand. The eastern part is utterly useless being quite inaccessible & the orders are to sketch it. But it is so broken up it is very difficult to sketch it with any degree of accuracy & the lagoon being so

inaccessible makes it much harder to do & entails an amount of bother quite inadequate to the results.

I have not yet decided what to do with it. Shoal water is reported to extend off to east end of the reef & I suppose something must be done to that. I shall probably have to take the ship there, but I grudge the time & labour. My report on this island as a telegraph station will be very discouraging. A pier over a mile long would have to be built for landing stores & landing a shore end of a cable over such an uneven bottom would be very trying on its cable I should imagine. The anchorage however is good & extensive & fairly smooth water.

...

Monday, May 24th

The 4-inch plan of the anchorage was in full swing, with all the staff on it. Tuesday I landed early, taking gear for the night. Pasco & I took the triangulations of the lagoon in hand & polished it off between us that day, I taking the south side & he the north side. Then in the evening I got stars for latitude which occupied me till 11 o'clock.

Next day I started Pasco off with the 'points' of the lagoon to do the coastline of all the island whilst I went on board to see how things had been getting on in my absence. It was Friday before I landed again, when I had a day at magnetism work at the observatory, where we have had a tent pitched & another tent for the tide party not far from it. Saturday Waugh & I were observing the sun for times on shore. Pasco had completed the island of the lagoon & the 4-inch business was finished that day, much to my joy.

...

Monday, the steamboat sounded off the island, including the east end, off which extends a very nasty bank with occasional breakers off it & I weighed in the ship to sound to the Southward & Westward.

## **Visit by Schooner Concord**

**Date:** April 4th, 1909

**Summary:** During a cruise through the South Seas, the crew visited Palmyra for several days. Well known paniolo Eben “Rawhide Ben” Low, spoke to the Hawaiian press about his trip, as there were rumors the Navy were interested in using the atoll as a refueling base.

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*Excerpt from a Hawaiian Gazette article<sup>13</sup>*

A moto is a small island, and Palmyra is split up into thousands of them. The water between them is not usually over two or three feet deep and is simply teeming with the most beautiful fish I have ever seen. One funny thing that struck all of us was the manner in which the baby sharks, about two or three feet long, resented our paddling around in the island waters. I wore my rubber boots, of course, but every time I waded between the motos I was attacked by these little man-eaters. They tried in every conceivable way to fasten their teeth in my legs, and sometimes I had to strike them off with the butt of my gun.

*Excerpt from a Hawaiian Evening Bulletin article<sup>14</sup>*

No habitation graces the islands in that group, says Low. We met with signs that indicated at one time the presence of several parties of poachers, but in my opinion they must have been natives from some of the neighboring islands, as they had in some instances carved their names on the trunks of cocoanut trees. There was nothing on the island that indicated that Japanese bird-poachers had visited there, at least for a number of years.

The place is simply overrun with sea-birds of almost every description in going about the islands we were continually obliged to exercise care that we did not step upon them as they sat about the ground. The ground in places appeared to be littered with the husks of cocoanuts, these presumably gathered by the visiting parties of south sea islanders.

The fern trees and the so-called bird's-nest ferns to be found in the interior of the larger islets were large and well developed. Many of the trees were much finer specimens that we find here.

Cocoanuts Galore

On my trip through the islands I counted three thousand bearing cocoanut trees. Other trees of the same nature but not bearing numbered over five thousand, and under this classification were ranged trees from eighteen months to four years old. I believe that the latter should in most instances be listed as full bearing by this time.

There is one solitary islet which affords lodgment for but a single cocoanut tree.

#### A Paradise for Birds

Birds find on Palmyra an undisturbed haven for rest and refreshment. They literally cover the ground and the well-known "love bird" was found in such numbers that the Low party were continually employing sticks to move them out of the way of the pedestrians. Eggs by the thousand littered the sand piles and some of the more protected reefs.

It is believed that some of the southern islands are at times visited by storms or hurricanes which cause high seas to completely sweep over them, carrying away nearly all vegetation and bird life.

#### Finest Fish Ever Eaten There

The finest fish that ever tempted a palate are to be found in abundance off the shores of Palmyra. From the Concord we dropped lines and the fish were brought to the surface in varieties to satisfy the most fastidious."

Young Low, who was left to his own resources on the island for a part of the time, dipped a net in the waters of the lagoon and soon had large sacks filled with a wide range of specimens of finny beauties which abound there. Sharks there were too, in large numbers. The smaller man-eaters were encountered by the boarding party as they towed their boat into the inner lagoons and waterways. The party used stout clubs to frighten them away when curiosity prompted a close investigation on the part of the sharks.

#### Land Crabs a Menace

Huge land crabs, the size of a well-developed rooster, were met with as the party pursued their investigation of the islands. These crustaceans were armed with large and powerful nippers,

which were capable of crushing sticks and presumably would have done considerable damage to fingers or toes had they been permitted to gain intimate acquaintance with the masculine intruders. Young Mr. Low is said to have succeeded in roping several of the specimens and preserved them for shipment to Honolulu.

## Visit by the USS West Virginia

**Date:** February 20th, 1912

**Summary:** The West Virginia was sent in secret by President Taft, to firmly establish US ownership over Palmyra, and rebuff counter claims from the British. While on the atoll, the crew took detailed surveys of its land and features, as part of ongoing investigations into its potential as a Naval base.

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### *Excerpt from the “Naval Exploration” section of the Army and Navy Register<sup>15</sup>*

A bit of Japanese writing picked up and taken aboard ship proved upon translation to refer to ammunition supplies contained in huge cases and ready for use there on May 7 of some unknown year. The mystery surrounding the use the Japanese intended to make of this ammunition is in keeping with the mystery and hidden secrets surrounding every foot of this unoccupied land, which provided new animal and vegetable life for the American naval officers to study and gaze upon.

...

The entire island is surrounded by a barrier reef of coral, in which formation a brown species prevail. The barrier is open to the westward; the entrance from that side is effected over an area having many coral heads, then over a ridge submerged in parts about two feet at high water, after which come three distinct lagoons. White coral and sand flats, having about six inches to one foot of water at low tide, extend inward from the surrounding islets toward the lagoons, the latter depth being attained immediately at the edge of the level white coral sand floor, where the coral shelf ends.”

On the islets were some cocoanut trees, an undergrowth of palm and young cocoanut, and an abundance of trees, the leaves of which looked like those of a dogwood, while its maimer of growth was that of a scrub oak.

Remarkable birds of many kinds flew about in great abundance — snipe, curlew, boatswain's birds, and small blackbirds with short bills and white spots on their heads. Great numbers of birds resembling frigate birds, except as to color, were observed nesting.

There seemed to be no sign of habitation of mankind or even the animals expected to be found. A peculiar, mysterious sign was found on one of the cocoanut trees. Close investigation showed it to be the initial "M" overgrown with moss. On another islet the initial "A" was discovered. A tree was later found which appeared to have been felled by an ax, and on the west end of the inland was found a gin bottle.

One exploration party sent out from the ship brought back as evidence of human habitation a piece of bamboo about 8 inches long by 2 inches in diameter and an empty bottle. Another party found two empty bottles. A third party found two broken bottles and a log that had been cut with an ax.

The fourth group found the same mysterious letter "M" carved on the fallen branch of a tree.

Another exploring group upon penetrating inward on islet No. 51, which was thickly wooded, found three huts not visible from the sea.

"One has a thatched roof," says Rear Admiral Southerland, "and two have roofs of corrugated iron, with 'Trade Mak Redcliffe' stenciled on upper surface. Dressed lumber has been used in part in the construction of each of these huts.

"One hut contains a table, shelves, stools, chopping block, and a low double stove open at the top and built of new red pressed bricks, with several old fire brick among them. A similar double stove is located outside of this hut.

“A second hut contains a new door fitted with a lock and a number of new empty oriental cedar cases, some of which have been marked on one end by pasting a piece of Japanese newspaper on the boards and writing on it. One label said:

“ ‘This case contains ammunition. May 7.’ ”

## Visit by the Luka

**Date:** July 12th, 1913

**Summary:** Having recently secured ownership over the entire atoll (the first person to do so since its discovery), Henry Cooper, a prominent Judge and partial architect of the annexation of Hawaii, visited Palmyra with several scientists and guests, to perform a full survey and determine what use he could find for the its resources.

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### *Excerpt from an article in the Honolulu Star-Bulletin<sup>16</sup>*

During the sixteen days the party spent on the island, four inches of rain was recorded by the instruments. The greater portion of this fall occurred at night. An almost daily rain squall sweeps over the group but is not accompanied by any severe gales as is the general rule throughout the tropics. The regular rainfall served to keep the visitors well supplied with drinking water, which was gathered and stored in barrels. With well-watered soil, cocoanut trees are said to thrive to a high state of perfection. Judge Cooper planted a plot with a variety of vegetables immediately following his arrival. The plants and vines appeared to force themselves right out of the ground. “I never saw anything like it,” he commented this morning in relating his initial experience as a small farmer on Palmyra.

While Honolulu sweltered in the throes of a heat wave during the latter part of July, the party of explorers at Palmyra were favored with cooling breezes and a temperature that was exceedingly pleasing.

“The lowest thermometer reading that we noted during our stay at the islands was 78 degrees, while the highest registered at ninety degrees. The maximum temperature prevailed for but two

days. The abundance of shade from thousands of cocoanut and other large trees makes life down there exceedingly delightful," said Judge Cooper.

...

Japanese are believed to have spent some time on Palmyra islands within the past two or three years...Near the hut also was discovered a large pit into which had been dumped the remains of many island birds.

...

At the least calculation there are twenty thousand bearing cocoanut trees on the several islands in the group, according to the members of the party. All are in a thriving state and the product simply drops to the ground where it finally rots and disappears. What augurs well for the cultivating of cocoanuts is the fact that no rats, parasites or leaf worms were found.

...

"We met with millions of birds," declared Professor J.F. Rock, who as a member of the party returned with cases filled with specimens, and also a collection of a hundred and fifty large photographs taken throughout the group.

The Bird life in the Palmyras is said to much resemble the varieties found throughout the Hawaiian bird reservation to the westward of Honolulu and occasioned visited by the U.S. revenue cutter Thetis. One peculiarity noted was that the birds find nests on the coral and solid rock. Available stretches of sandy beach are not plentiful. Every variety of bird know to the south seas is to be found.

The possibilities for guano are not bright. Judge Cooper paid considerable attention to this feature, but stated this morning that little or no guano was found on the islands visited. No animals or rodents of any description were discovered, though a search of many days was prosecuted with this object in view. The same result followed in seeking snakes or other reptiles.

...

The waters adjacent to the islands are said to be infested with ravenous sharks...The average height of the islands at low tide is estimated at from six to eight feet. The party found the best of fishing, and of a variety similar to those found in Hawaiian waters.

C. Montague Cooke, curator of the Bishop Museum said this morning that probably the best collections to be made on the islands were those of coral and crabs, there being a wide variety of the latter, weighing all the way from 15 pounds down to a few ounces. A large number of

different species of native birds infest the islands and are widely distributed, principal among these being boobies and terns.

"The chief characteristic of the islands are the jungles of birds nest ferns of which we brought back several specimens," he said. "It was impossible for us to ascertain the number of islands in the group, but I believe at low tide there may be as many as 52. In all, we brought back 12 species of plant life.

"There were sharks galore all around the islands and we found this out especially when we were wading from one island to another. One of them started taking a nip at me, and I got out of the vicinity in lively fashion."

*Excerpt from an article in the Mid Pacific Magazine<sup>17</sup>*

We landed on "Home Island" on the afternoon of the eighth day from Honolulu, and immediately set up our tent on the weather side. As night settled down we began to wonder if we would need our mosquito nets, but it passed without a sound or other sign of the pest, and we realized that there were none. Neither were there house flies, fleas or other noxious insects. The hermit crab was the only creature we had to deal with, and to get rid of him we had "picking times," when we would go out with a bucket, pick them up and put them in boxes and bags and deliver them to a sailor from the Luka, who would take them out to sea and dump them overboard.

Our first meal on the beach was cooked over a roaring fire and consisted of roasted fish and eggs. The eggs of the black and white tern proved fine eating. Later we added cocoanut crabs to our menu. These proved delicious eating, as they feed exclusively on cocoanut, and their flesh is of a most delicate flavor. The large ones were about the size of a good-sized hen. They are very nearly the shape of a lobster and as easily handled ; the stories about their warlike nature are without foundation.

...I began to build our permanent camp and the planting of our gardens: bananas, mangoes and various kinds of vegetables. We also planted some sugar cane furnished by the director of the planters' association experimental station. The cane grew well at first, but was later attacked by the hermit crabs and destroyed by them, notwithstanding our efforts to protect them by numerous

"pickings." A thorough campaign against these pests would have resulted in their extermination, but as it was we could only keep them partially subdued.

The heliotrope tree furnished the foundation blocks for the house, as samples left by the Japanese showed them to be firm and tough.

All about our house there were numbers of the white tern, or "love birds." They were very beautiful, and so tame they would flutter about us all day long; the most interesting thing about them was the manner in which they reared their young. A single egg would be laid on a tree without a nest to prevent it from rolling off. A slight depression or a twig was the only protection, and the young would be hatched and cared for in the same place until able to fly. There were myriads of the black and white terns on the bird islands. It was nesting time while we were there, and at first I was somewhat timid about walking through their colonies on the sands. It seems as if they might at least give one a good threshing with their wings, and I carried a stout stick in my hand the first few trips, but soon learned that they would do no harm. Many remained on their nests and could be easily picked up.

All around on the inside of the horseshoe line of islands there is a stretch of fine white sand which is covered by about two feet of water at high tide, but which is nearly bare at low water. One can wade about between the islands and also from the islands to the deep water lochs, as we called them to distinguish between them and the lagoon proper.

One of the most enjoyable afternoons to me was spent in drifting over the reef in a skiff with a water glass over the stern, through which could be seen the wonderful colors, including all shades, from the reds to the most delicate of pink, with dashes of brilliant purple shading into lavender and lilac, interspersed with great blotches of yellow set off with radiant bits of pure white sand. The fantastic forms of the coral, and the many hued fishes made a fascinating spectacle that could be viewed again and again without tiring.

...

The size of the cocoanut, and species of heliotrope trees, which appeared to be in flower all the year around, puts in mind the possible industry of bee-keeping.

Other large trees were wiri-wiri, which is not to be confounded with our tree, the will-will, being a distinct genus. Considerable forests of these trees were found on several of the islands. Another

group of trees was found on another island, which I believe to be identical with the holei tree in our Hawaiian forests. There were also considerable forests of pandanus, of a different species from our own, having leaves longer and of a finer texture. The largest tree on the island belonged to the wiri-wiri family, being twenty-one feet in circumference five feet from the ground and with a height between eighty and one hundred feet.

Of the possible industries, copra-making clearly takes the lead. About one-half of the available area is now covered with cocoanut trees, but many of these will have to be removed, as they are too thick to bear heavy crops.

The great supplies of fish should be taken advantage of in some way, possibly by the erection of a cannery. Mullet are in great numbers; also many other edible fish, including ulua, houmea, moi, uhū and others whose names I fail to remember. It seems strange to speak of fish being tame, but the first mullet were brought in by one of my friends, who scooped them up with his specimen-collecting net, and the use of a rough Chinese-made net, which we put together at the islands, yielded us a boat-load in a few hours. Five hundred of them were brought back in pickle and will be sampled in a few days to ascertain their condition.

The total area, as calculated by the survey department from data in its possession is 351 acres. The smallest island has an area of thirty-one hundredths of an acre and the largest is forty-eight acres.

## Visit by the Sampan Sanyo Maru

**Date:** October 30th, 1920

**Summary:** The Sanyo Maru ferried young Hawaiian men to colonize remote Pacific islands and atolls, as part of the US Government sponsored Hui Panal'au mission. Their first stop was at Palmyra, to collect plants and other supplies on their way to other locations.

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*Excerpt from an article in Mid-Pacific Magazine<sup>18</sup>*

...The next day, trying to make a landing from the sampan's motorboat, the tide went out and left the boat stranded on an even keel for seven hours. After learning that landings could only be made twice in 24 hours owing to the two-foot tide and shallow water, the party worked with each tide.

During the night high tide, beacon fires were built between two adjacent islands to act as range lights in making a landing. Considerable trouble was had keeping the island birds from flying into the flames.

Plenty of fish, including ulua, ama-ama and uhu (bluefish), were found, and it was easy to catch them with a throw net. The sampan brought back some fine specimens. The island was found to be filled with eggs, having a fine flavor when cooked. The birds do not sit on their eggs to hatch them, but allow them to be hatched by the heat of the sun.

...

Edward Benner, Jr., who is but a boy in his teens, was the first to ever mail a letter from Palmyra.

Naturally it was to his mother. Here it is :

10:30 a. m., Sunday, Oct. 31.

Home Island, Palmyra.

...I came alone in my canoe. The first fish I saw on the way in were three nice eight or ten-foot sharks. My heart stopped for a while, but continued after a time. The water was deep, but there were hundreds of coral beads or pillars ranging from eight to twenty feet in diameter. Long before I got to the island, maybe while I was yet one-half a mile off, I could hear the birds chattering. I landed on the western side and walked through the under brush, mainly birds' nests, ferns and young coconuts, and found Cooper's house...That evening we men went around the island (it contains about three acres), and killed hermit crabs that are here by the hundreds. We killed between seven and eight hundred...Ran aground on the coral beds so worked more to the north to try and make the little channel into the lagoons. The tide was going out and we couldn't make it. We got out, me in my wooden-soled shoes, and pushed and hauled it as far as the bar at the lagoon. I then walked over here. There wasn't more than three or four inches of water the whole way over. At 11:30 the colonel and I went over in my canoe. We had to carry it from the

house to the lagoon, about 220 yards. We finally had to turn the canoe over on the bar, which was now above the water, and walked to the boat. Tulloch and I then took a walk over to Swale Pt. and Strawn Island, about three-fourth of a mile from the boat. The deepest it got was four inches in a little channel. There were dozens of two or three feet long white eels in the water and shoal places. I speared one with my knife and also a small six-inch fish. Oh, I forgot to say the reception committee of crabs, fish and birds were right on deck when I landed at Home Island. Also the coconut crabs are swell.

7:30 p. m., Monday.

At 5 o'clock we saw that they had started and were in the lagoon looking for a channel. We never paid any more attention to them until after dark and then heard a call. I went out in the canoe and met both of them walking in—they couldn't find a channel... During the afternoon Tulloch, Captain Peterson, Toki and I walked east along the islands and shoals as far as the island opposite the eastern end of Cooper Isle. It was low tide so we didn't get wet above our knees...We left the canoe there and waded back, as it was low tide. Tulloch and I went over to our poultry island—two islands east of Home Island and got half a bucket of eggs in about five minutes...I believe there will be at least 30,000 bearing trees when everything is cleared out. There are about 100,000 all told now, but are too close together. The trees on the southern island do not appear to be bearing as well as those on the northern. I can't figure why. It has rained every morning, afternoon and night, so I guess we won't be lacking for water...The fish are very easy to catch either with net or line.

## **Occupation by the Mengs**

**Date:** October of 1920 to November of 1921

**Summary:** Mr. Meng and his wife, Idelle, along with a young man named Edwin Benner, were hired to live on Palmyra for a year, to determine if permanent structures could be erected and maintained, to produce copra and harvest other resources.

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*Excerpts from an article series in Wide World Magazine*

## **Part I<sup>19</sup>**

The group spreads east and west in the shape of an elongated horse-shoe, encircling five lagoons.  
These lagoons range from six to thirty fathoms in depth. Around the group and following its outline is a coral reef, not more than one-fifth of a mile outside the islets. The crescent, or horse-shoe, formation of reef and islets opens toward the west. From this side only can a small boat make an entrance into the lagoons; it is also the only side of the group where a large vessel can be anchored in safety."

...

After the skipper had given some final orders to the crew our little craft started on the mile-and-a-half trip to the islets. In the clear crystal depths could be seen wonderful growths of coral which kept me in ecstasy. I have never seen such wonderfully-coloured fish, and such queer ones, as those that darted beneath our small boat; nor were sharks absent, their long, sinister-looking bodies darting here and there...After grounding several times on the top of coral-heads and shoals, we at last reached the outermost atoll, known as Home Islet...

...

Numbers of hermit crabs were everywhere. I had never seen any kind of crab that inhabits a shell before, so was much interested in examining them. It seems impossible that Nature has not given them a shell of their own; but so it is, and they hunt up the discarded shells of a certain sea-slug and appropriate them for their own.

...

The first trip the motor-boat made out to the sampan it returned all right, but the second load was only half-way back when the little craft grounded on a shoal. Mr. Tullock and Tokioyama happened to be the unfortunates in the boat. They dared not try to wade to shore as the water teemed with sharks ; so there they stayed in the hot sun, without food or water until the tide began to come in again. This proved to be a valuable lesson; after that trips were only made during the first part of the high tide.

...

Between the islets are channels leading from the sea into the lagoons. Some of these are only ankle deep while others are waist deep. We picked our way carefully in crossing these channels to avoid falling over the rough coral rocks. In stepping from one large coral-head to another we often saw the huge, ugly bodies of black conger eels coiled down between the two rocks.

...

In crossing the shoals and channels we were kept in a constant state of excitement by small four-foot baby sharks which rushed toward us, attracted by the sound of the splashing water, as we waded along. The instant they heard the noise they would make a dash for us, leaving a wake behind them like a torpedo boat.

...

Strange to say we did not tire of coconut crab as we did of fish, while we rarely went to the trouble of catching lobsters, although they were quite plentiful along the reef. The lagoons and channels literally teemed with fish. Most of the varieties are edible, though if one were to take a notion to eat any of the vari-coloured species I am sure he would feel that he was eating the rainbow and would suffer from “painter’s colic.” The huge “balloon fish” were most interesting. Upon being disturbed they would immediately inflate themselves to twice their normal size and roll around helplessly. Mullet, which sells at an enormous price in Honolulu, is probably the most plentiful of any variety found at Palmyra. They feed along the shoals and inlets and will go leaping like goats into the air when disturbed. Their leaps and bounds do not vary more than a few inches in distance and they are actually in uniform line.

### *Part 2<sup>20</sup>*

...I remember on one occasion a huge black conger eel poked his ugly head from a crevice in the coral rock on which I was standing fishing, and rubbed against my bare legs in his endeavor to reach the net that contained my catch of fish. I immediately beat a hasty retreat and started fishing farther down the lagoon. The eel followed me, and when he got his fangs tangled in the mesh of the net I stunned him by giving him a blow on the head with my knife. His skin was so tough that it did not even make an indentation in it. Thinking him dead, I looped my leather belt around his ugly throat and dragged him through the shallow water to the shack. When my husband saw me coming he thought I was bringing in a big fish, so he came out to meet me. He was horrified that I should have come in close contact with such a monster, and was even more so when he discovered, on removing the belt, that the eel was very much alive. He weighed forty-four pounds and was five and a half feet in length.

## **Visit by the USS Eagle 40**

**Date:** September 21st, 1921

**Summary:** The Eagle 40 and its crew of pilots and photographers, were sent with some of the world's earliest aerial cameras (and a disassembled plane), to create a mosaic photo map of Palmyra. The aerial images would aid US Government officials in evaluating Palmyra's use for various special projects, including a refueling base for the emerging needs of US Navy flight crews.

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*Excerpt from an article in the Honolulu Star Bulletin<sup>21</sup>*

"While getting the plane over many large red snapper and ulua were caught by the crew. The writer claims the distinction of hooking the largest fish, but must share the honor of landing it with two others. ...133 pounds of silver ulua was gasping and flopping all over the deck.

...

On our isle, a sanded and coconut shaded wee bit of coral on the edge of Central Lagoon, stood the mansion of the pioneers, and here Colonel and Mrs. Meng and Edward Benner, after a year of isolation, were at home that afternoon to visitors.

Their home consists of a long lean-to with the closed side in the direction of the prevailing winds. This is divided into three sections by partitions, the front being left entirely open except for curtains, which, in the raised position, make quite efficient awnings. All cooking is done in the open over a mud and tin fireplace. Our isle is just large enough to contain shelter and to provide, in addition, a front yard of about 40 square feet.

The decision by several of the officers to remain on the island during the stay of the expeditions was heartily endorsed by our hosts, who indicated quite clearly that they watchword on Palmyra as "The more, the merrier."

Colonel Meng and Lieutenant Mecklenburg, our noted caster of flies, went to spear mullet in the lagoon shallows."

*Excerpt from an article in Hospital Corps Quarterly<sup>22</sup>*

“...we were anchored off the western reef in 10 fathoms of water, so clear that the coral bottom, which could be clearly seen, resembled a many-colored tile floor.

While the plane was being assembled and put over the side the officers and crew tried their hand at fishing, and within an hour and a half a ton of red snapper and uulu was on deck. The red snappers weighed from 10 to 25 pounds and the uulu from 70 to 130 pounds.

The group is shaped like a horseshoe and comprises 53 islands, covering in all about 500 acres.  
They are coral islands of the atoll type and completely surrounded by a barrier reef, inside of  
which are large, deep lagoons. Their highest elevation above sea level is about 7 feet, and they are densely covered with a growth of wild heliotrope bushes and coconut palms which grow to a height of 90 feet or more. Millions of birds, such as tern, curlew, love birds, boobys, and frigate birds nest here, and, having had no enemies, are exceedingly tame. The lagoons contain many varieties of fish of all shapes and all colors of the rainbow and are a source of interest and delight to a naturalist. There are no animals or snakes on these islands and they are free from mosquitoes and other poisonous insects. A great number of shellfish are found about the reef, and here the coconut crab grows to an enormous size, and is highly prized as an article of food. In taste it resembles the New England lobster but the flesh is much more tender.”

## Visit by the Sampan Palmyra

**Date:** May 4th, 1922

**Summary:** This exploratory voyage was funded by prominent media mogul Lorrin Thurston, to help determine Palmyra's suitability for fishing and other industries. He published the story of the crews' exploits in his newspapers, but also donated detailed descriptions and physical specimens of various species native to Palmyra, to the Bishop Museum. These would become crucial parts of early biological studies of the atoll.

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*Excerpts from an article series in the Honolulu Advertiser*

*Part 2<sup>23</sup>*

"For instance, on three separate occasions "inquisitive baby sharks" approached members of our party, and, declining to be frightened away with splashes kept coming head-on, until they were stopped by being spiked in the nose with an ice pick. Whether the intention of these "babies" was to caress our shins with their hides or whether they were in search of meat I do not know. Certain it is they were some "inquisitive babies!"

...

We were exploring along the shore of Samarang Island - the easternmost of the chain of 53 sub-islands which constitute Palmyra, when I came to an inlet. It was about a quarter of a mile around but only 200 feet or so across the mouth. The water appeared to be only knee-deep and I started to wade across when one of our party who was just ahead, called out: "I wouldn't advise you to wade across there this morning!"

"Why not?" I inquired.

"Because," he replied. "I started across there just now and I hadn't gotten 30 feet before 12 sharks started for me, six coming from each side! I jumped up and down and splashed and made all the racket that I could but they kept right on coming straight for me. I ran out of the water onto the bank here to escape them, and the beggars followed right after me to the very edge of the beach!"

...

Trolling hooks and lines had previously been prepared and were quickly thrown overboard, each with a slack line about 100 feet long. The bait on each hook was a bunch of greenish black rooster tail feathers, tied firmly around the shank of the hook, concealing it from view.

No sooner were the hooks overboard than "strikes" began in rapid-fire succession, sometimes two fish being hooked at the same time.

...

The instant a "strike" is made, a fisherman grabs the line barehanded, with the exception of a glove-like tip on the forefinger, over which the line is allowed to play, and "snubs" the fish in a succession of jerks. As the sampan is traveling at the rate of nine knots an hour, this speedily forces water down the throat of the fish. The sampan is then slowed down and two men on the line yank the fish in as fast as they can pull. When he gets alongside a great steel gaff on the end of a six-foot pole is driven into his gills and he is almost instantly hoisted aboard.

...

During the next 30 minutes I passed through one of the most intense experiences of my life! Great ahi (yellow-finned tuna), ulua, ono, "Hawaiian salmon" and other game fish of the tropics were hauled aboard in quick succession. None of them were under two feet in length nor weighted less than 25 pounds, while numbers were from four to six feet long and weighed up to and over 100 pounds each, with now and then one so big that it even drew exclamations from the normally stolid fisherman!

...

The third fish hooked was a giant "yellow-finned tuna." The hook was only 100 feet astern and just under the surface of the water, so that the action of the fish was plainly visible. He came up from behind like a streak, inspected the bait and then shied off some 20 feet to the right, evidently to think it over; then concluding that the strange looking fish was all right, he made a dash at it with a motion so swift that he looked like a mere fleeting shadow. The instant the hook took hold he sprang straight up, clearing the water some six or eight feet, where, for an instant, he was silhouetted full length against the sky.

...

The prosaic snubbers on the deck of the sampan, giving no attention to the magnificent opportunity for a battle royal, dragged the tuna remorselessly to the gun'l of the sampan. Just as the gaff was about to be thrust into his gills, a giant shark rushed from the depths straight at the tuna.

...

Right side up and straight ahead, without a moment's hesitation, the shark came straight ahead and at one gulp snapped off the entire body of that giant tuna, cutting it off just back of the gills, as clean as though amputated by a cleaver. Leaving the head, 15 inches in diameter, as the sole evidence that a 100-odd-pound fish had hung there an instant before."

### *Part 3<sup>24</sup>*

We arrived at the anchorage, some two miles off shore, too late to land that night. During the evening one of the party amused himself with a hook and line. The water was some 30 feet deep, and in approximately half an hour he landed 25 fish of 15 species.

During the next few weeks we found that in the deep lagoons scattered about on the main central platform of the island; in the narrow channels which separate the numerous "sub-islands," and on

the central platform itself, which is “awash” at low tide or bare, and two to four feet under water at high tide, the same conditions prevailed.

...

As to mullet - the same mullet that is the fish delicacy of Hawaii - except that they are somewhat lighter in color, - the word “school” does not adequately designate them!

They are in “swarms” - in “clouds,” as they sweep across the shallows and crowd the inlets and shores of the miniature islands!

Mullet are naturally a timid fish, by reason of the fact that in the various stages of the growth they form a principal source of food supply to almost every fish that swims.

Notwithstanding this, and the constitutional nervousness growing out of the necessity for being constantly on the qui vive for danger, as the price of life, they appeared to have no fear of a man if he stood still, or moved slowly and quietly.

A school of mullet on the move, covering a quarter of an acre or so, would simply divide and pass around a man in water not over two feet deep, as unconcernedly as though he were a post or a coral head.

A single fling of a “throw net” usually provided two or three times as many mullet as our party of four could utilize.

...

The ulua were constantly patrolling the narrow channels between the islands in search of prey. Young Theodore Dranga, who was our prize fisherman, conceived the brilliant labor saving scheme that, instead of enduring the fatigue of sitting in the boat, holding a line, he would string a rope across the 300-foot channel which separated the island on which we were camped from the next island, on which rope he would tie several lines attached to baited hooks, which would dangle in the channel. No sooner conceived than executed - the rope was suspended across the channel and three baited lines suspended from it, trailing in the water beneath.

Three successive violent commotions under the line indicated the successful working of the scheme; but the aftermath was disappointing, for in each case the catch proved to be a shark - a “baby shark” to be sure, not over four feet long, but still involving a struggle to get him ashore

and rescue the hook from his yawning jaws and snapping teeth, for even a four foot "baby shark" can put up a vigorous fight, and, as we later discovered, his baby teeth were not made for looks alone!

I was cleaning shells near our end of the suspended rope when I was aroused by an explosion of expletives from Dranga, who as he rushed by me like a streak, bellowed, "there's another of those blankety blank sharks after my bait again!"...

It developed that instead of a shark dallying with the bait this time, it was an ulua, which afterwards proved to be three feet long weighing about 30 pounds.

...

While the ulua was being dressed for dinner, the fact that it contained a mass of eggs revealed that it was a female fish. After that one of the stock gags of the camp, at Dranga's expense, was that he had hugged to death the only lady we had met at Palmyra.

#### *Part 4<sup>25</sup>*

...Ted Dranga, our fishing expert, threw the casting net, enveloping a small school of Ma-ni-ni, or "Conviet fish," a flat, round fish, some four inches in diameter. Taking these for bait, he rowed over in the flat bottom skiff, to the lagoon, baited his hook with a Ma-ni-ni, dropped it overboard and prepared to await results. Before he could think twice results began to happen.

The line stiffened with a snap that cut into his hands and nearly jerked him overboard.

With visions of a big ulua for dinner running through his mind's eye, Dranga dragged in his catch, until there loomed up from the depths before his startled eyes a giant eel, struggling, squirming, tying himself into a figure eight and churning the sea into foam! It was not an ordinary brown eel, but was of a brilliant yellow color - as yellow as lemon peel - with long rows of inky black rings an inch or so in diameter, extending along its sides for its full length and peppered all over with black dots. It also had an erect, continuous fin four inches high, extending along its back from head to tail, which with its wide open mouth lined with gleaming sharp teeth, gave it a most menacing appearance!

...With a convulsive shudder the eel raised its head, opened its mouth and disgorged a "Ha pu-u-pu-u" (a sort of rock bass) fifteen inches long and a head that was all mouth, some five inches in diameter!

The Ha-pu-a-pu-u had been bitten square in two, across the middle, the tail half being attached to the other half by a mere shred of skin.

The fish line entered the mouth of the Ha-pu-u-pu-u, and upon prying open its cavernous mouth, the Ma-ni-ni bait was discovered at the far end of the Ha-pu-a-pu-u's stomach unmangled with the hook still attached as it had been placed by Dranga - but protruding so that it had stuck into the interior of the stomach of the Ha-pu-a-pu-u!

## Visit by the USN Whippoorwill

**Date:** August 15th, 1924

**Summary:** The Whippoorwill was a minesweeper, who after serving in WW1, was tasked with assisting in surveys of Pacific. In 1924 she ferried a team of scientists, on behalf of the Bishop Museum, to remote islands in the Pacific, as part of a geological study of the pacific.

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### *Excerpt from journal article in Bishop Occasional Papers<sup>26</sup>*

This group of tiny islets is the northwesternmost member of the Line Islands. It includes upward of forty small islets which are arranged in an atoll ring 4 miles long and 1.5 miles wide. These stand on a reef platform 6 miles in extreme length and 2 miles wide. (See fig. 7.) The axis of the shallow reef platform trends almost exactly east and west and is continued at each end by shallow water for some distance farther. The total area enclosed with the 60-foot line is 11 miles in length. At the west end of this area is a pool which is somewhat deeper than 60 feet and inside the reef platform proper and inside the ring of islets are three principal pools which have depths from 100 to 150 feet. Outside the 60-foot line the submarine slope is steep, ranging from 2500 to 3000 feet to the mile and descending to the general depth of about 15,000 feet.

None of the islets is over 50 acres in extent and most comprise less than 5 acres. (See PI. IV, B.) Around the north, east, and south sides of the ring, the spaces between the islets are considerably narrower than are the islets. The west end is open with a distance of over a mile between the two ends of the atoll loop. This is in close accord with the form of the reef platform which presents a single blunt point to the prevailing ocean current and has two sharp "fish-tail" points extending westward in the opposite direction. It is apparent that the most favorable places for growth are at the current-ward point and at the two points, one north and one south, where the along-shore currents run out past the main part of the platform.

Practically all parts of the reef platform are accessible by wading at low tide, the only exceptions being the central pools and the interislet channels. The writer found no points on any of the islets over 5 feet above sea level and is confident that the maximum elevations will be found to be less than 10 feet in elevation.

No detailed or extensive examination was made by the writer of the reef surrounding Palmyra but it showed to casual observation similar features to those of the other atolls visited. Because of the large number of breaks between islets, study of the channels across the atoll rim was more effective here than at others of the Line Islands. No data are at hand to show the amount of lag between high tide outside the lagoon and that inside but it probably amounts to a considerable part of an hour at the least. During the approach of high tide and for this unknown period afterward, there is a strong current through each of the interislet channels which keeps the bot-tom scoured clean and maintains depths of 4 to 8 feet. Coral debris carried by the channel current is deposited well inside the narrower part of the channel in a fan which is commonly not over 1 or 2 feet below low tide and in places is emergent at low tide. These fans merge more or less inside the islet ring and the debris is spread widely over the detrital plain which occupies the whole area inside the rim, except the central pools, as shown on the map.

So far as the writer was able to observe, the outgoing current, which is set up with the reversal of tidal relations, is less strong and of shorter duration—probably in part due to the greater amount of water which flows out the west end of the atoll. Though a small amount of debris is probably carried out at this time, it is small in amount in comparison to that which is carried in by the ingoing current and because of exposure to rollers of the open ocean no fans corresponding to those of the inner side are formed. At the east end, several hundred yards eastward of the dry islets, a few small emergent sand patches were seen and one of these bore a single tree marking

the beginning of conditions which will lead to stabilization. These were not visited but seem clearly to indicate that the more favorable growth of reef-forming organisms, in the direction of the prevailing currents, is more than competent in spite of severe wave abrasion to maintain its position.

In the central pools and around their margins, as well as in and adjacent to the interislet channels, there is a considerable amount of living coral and associated organisms, but the growth here is apparently much less vigorous than outside the rim and it is gradually being overwhelmed by the calcareous debris which is constantly carried in from the outer reef.

The outer beaches of the Palmyra Islets are composed largely of sand but some are made of coarse coral gravel. The inner beaches are low and less well defined, being composed of fine calcareous sand and mud. The angle is very low and the water line fluctuates widely between high and low tide. On the dry portions of the islets visited by the writer, mostly on the south side of the lagoon, no true coral reef rock was seen. There is thus no clear indication of a former sea level above that of the present day. The inner parts of the islets consisted chiefly of loose detrital material though certain ones were more largely made up of cemented sandstone and conglomerate; particularly with an inner line of islets on the east end, where the outermost islets seem to be more recent and doomed in time to be superseded by a line of isles flung still farther eastward toward the margin of the reef platform.

There are two plausible explanations of the lack of high reef rock on Palmyra. It is possible that the island had not come into being at the time of the 12-foot eustatic shift of sea level which is believed to be responsible for the emergent position of most of the Line Islands. On the other hand, it may have had an imperfect development and been cut away by the waves instead of becoming fixed as a dry land area as was Jarvis Island. If Palmyra Island were to emerge at the present time by 12 feet it would form an island about 5 miles long with three interior lagoons of a size and form not differing greatly from the interior basins of Washington Island, except that the former have a greater depth. It is conceived that the complete closing of the atoll rim for considerable distances on Washington, Fanning and Christmas islands was greatly aided by an emergence which took place apparently before Palmyra Island had developed to such an extent as to profit by it.

## Visit by the Sampan Lanikai

**Date:** August 5th, 1935

**Summary:** A group of 15 Honolulu citizens, mostly teachers and students, chartered the Lanikai for a leisure cruise to Palmyra. They, along with the ships Captain and his wife, spent 11 days fishing and explore the islets.

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### *Excerpt from an article in Paradise of the Pacific<sup>27</sup>*

Our introduction to Palmyra fishing came with a rush. True we had been told that here were waters teeming with fish, but most of us had taken this information with the customary grains of doubt...Let my diary of that first evening speak for itself: "It was now growing dusk, so the captain decided to take temporary anchorage on the easterly side for the night. In the last few minutes before the anchor went over, the trolling lines at the stern brought in a 30- pound ulua, a 30-pound tuna and a 100-pound shark. Everybody excited about the fishing; don't know if we ate supper or not. Hand lines and sport lines began going over the sides and stern in real earnest. At first it looked as if there was nothing but sharks to be caught, as they began taking bait from everyone. There was a half-moon, and in its light we must have looked like a gang of pirates fighting over the spoil.

Too much work to pull the sharks aboard alive and flopping so all sorts of firearms came out and were put to work. As soon as a shark was brought to the surface it was drilled with one or half a dozen bullets, depending on the marksmanship of the gunners who were lined along the rail. The largest sharks were depending on the marksmanship of the gunners who were lined along the rail. The largest sharks were dropped back into the water as soon as the hooks could bereaved, but the little fellows were brought aboard and cut up for bait. In an hour or so this epidemic of sharks began to fade out and schools of ulua and red snapper came to take their places. We now began to bring in these fish as fast as we could haul in the lines. It was not a question of waiting for a bite; they struck before the sinker could hit the bottom. Exhausted from fishing I climbed up the ratlines and looked down on the gory battle and wondered when I'd wake out of my dream.

About 11 o'clock the captain decided we had enough fishing, so we took another hour to hose down the deck, clean the fish and put them in the ice room—not less than 500 pounds for this

night's work. But after everybody else was in bed, Jim Makin slipped down to the ice rom for more bait and when we arose early next morning we found him still fishing, tired and sleepy but gloriously content over a washtub of ulua and red snapper.

Shortly after breakfast we lifted anchor and began to cruise slowly outside of the northeasterly reef towers our permanent base, the panorama of numerous small islets which make up Palmyra unfolding in pale and dark green for us...Gradually we circled to the left and at length dropped anchor on the westerly side of the group, about a mile and half off shore and equidistant from the two points of the horseshoe which is formed by Palmyra's sixty or more islands. Here the water was about seven fathoms deep and so clear that we could plainly see the giant heads of mushroom coral which comprise the ocean bottom at this spot.

In the days which followed our first fishing experience, we were to learn that sharks are an ever-present menace to satisfactory angling. Particularly was this true in trolling with regulation tackle, but those who fished with the heavier landlines had their shark troubles too. We trolled in light skiffs with outboard motors and learned to our dismay and with the loss of dozens of hooks and leaders that any fish allowed to stay in the water more than two or fifteen minutes after the strike is as good as given outright to the sharks. Evidently it takes about this length of time to organize for the attack, though on occasion they gave us trouble within a minute or two after the strike. My diary for one if these days reads as follows:

Trolled with Jim this morning and discovered all this losing of hooks is not so much from game fish as from sharks. They grow bolder today and in the calm water we could see them gathering around, even when the fish was almost ready to gaff. Finally they would close in, theater would redden with blood and up would come the line minus hook and leader. Jim lost a large Hawaiian salmon in this manner not ten feet from the skiff. Shortly afterward I hooked a big Ono and had him on for ten minutes. He was fighting near the surface but coming in nicely about fifty yards distant. Suddenly we saw a great commotion in the water...Sharks by the score were at the feast, fighting for the choice morsels; the water all around was brown with them. Enos stepped on the gas and half a dozen big fellows charged at the wake from the propeller, evidently thinking it was another fish. We could have reached back and scratched their noses, but we didn't.

...Diving with water goggles in these sheltered water we found a new life and a new world below the surface, more colorful and more interesting, if possible, than that of our own natural element.

Within the horseshoe of islets lie three large lagoons, with water of deepest blue. Bordering these are shoals of aquamarine, while near shore the coral sand takes on tints of gray or tan. It was in these shoals that the vacation party obtained its most strenuous physical conditioning. At high tide the water is scarcely a foot and half in depth and at low tide is too shallow for boating. For as far as a quarter mile at a stretch when the tide was out we found it necessary, time after time, to drag the skiffs over these tidelands, pulling blocks of loose coral out of their way, and sometimes laying down a skid way of sea cucumbers to make them slide more easily.

In the less elevated spots of the reef, in water noticeably warm and hardly more than four inches deep, numerous small sharks swam excitedly about at our approach; schools of mullet, awa and young ulua darted hither and yon, and mud-colored balloon fish rolled lazily about, swelling to enormous sizes if we touched them. Here also coconuts floated by the dozens, already sprouted and bearing an upright stem or two. Drifting about with the current, they awaited a favorable wind or tide to give them permanent habitation on some nearby islet.

## **Naval Construction History 1939 to 1945**

### **Introduction**

The major military construction projects on Palmyra are well documented in a variety of sources. This summary presents the key features of these massive earth shaping projects, as it relates to the Western lagoon.

For a period of at least 5 years (1942 to 1947), and likely closer to 16 years (1942 to 1958), the only means by which water could pass in and out of the lagoon system, was through the 20ft deep, 200ft wide channel leading from the ocean to the Western end of the West lagoon. Moreover, any water in the Eastern and Central lagoons would have to move into the Western lagoon, before it could reach the channel. To this day, the flow of water is still greatly restricted compared to what is described in earlier literature, though the continued erosion of outlying islands and causeways has done much to open back up the lagoons to the ocean and reef flats.

### **General History of Activity**

The following is a general overview of the military construction activities on Palmyra, with an emphasis on those materials and activities that most impacted the atoll's Western lagoon.

All construction projects on Palmyra were completed by two distinct groups:

- Employees of the Contractors, Pacific Naval Air Bases companies (CPNAB, active 1939 to 1942)
- Members of the Marine Construction Battalions (Seabees, active 1942 to 1944)

CPNAB contractors, arrived on Palmyra on January 26th of 1940, and immediately began work on a temporary boat channel, connecting the ocean to the Western lagoon. To accomplish this, Hawaiian skin divers would hand drill six foot holes into the reef, every 22 inches, drop in a capped stick of dynamite, and blast one row at a time. By April, a 40ft wide, 7ft deep channel was cleared, and the workers took up permanent residence on the islets.

In December of 1941, in response to the attack at Pearl Harbor, formal Defense Battalions were stationed at Palmyra, and by March of 1942, all construction activities were taken over from the private contractors by the Seabees. By June of 1942, the main channel had been dredged to 200ft wide and 20ft deep, with an additional 750ft wide, 10ft deep area dredged between the Western and Central lagoons, for use as a Seaplane runway.

Most material from these activities was used to connect various islands, especially Menge and Cooper, who now offered 46 acres of functional land, which would eventually hold over 50 buildings and facilities, capable of housing 6,000 personnel, along with two runways, one of which is still functional 6,000ft today. The remaining dredged material was used to build 12 miles of roads and causeways, connecting all but Sand, Barren, and Bird Island. The main facilities of Palmyra on Cooper and Meng were in regular use for a period of approximately 7 years (4 years by the Navy and 3 by the CAA), while the other islands were shut down and largely salvaged by early 1945, and most functional equipment was returned to Pearl Harbor by October of 1946.

## **Materials Introduced**

During and after the construction projects, a variety of chemical and foreign materials were introduced to Palmyra, as summarized below.

### **Fuel, Oil, and Lubricants**

As of 1943, the following amounts of material were maintained on Palmyra. These numbers likely never increased, and were maintained to some degree at least into the late 1940s.

Type	Amount
Aviation Gasoline	796,000 gallons
Motor Gasoline	53,800 gallons
Fuel Oil	55,000 barrels (2,310,000 gallons)
Diesel Oil	30,600 barrels (168,000 gallons)
Lubricating Oil #1100	6200 gallons
Lubricating Oil #1120	8600 gallons

The following excerpt describes the facilities constructed to house these materials:

*...on Cooper Island...two 200,000-gallon tank-farms for aviation gasoline, two 13,500-barrel fuel-oil tanks, two 17,500-barrel diesel tanks...On Menge Island, they built two aviation-gasoline tank farms, one of 125,000-gallon and the other of 175,000-gallon capacity, a 633-foot sheet-steel bulkhead...and a fuel-oil tank-farm.*

The Diesel was primarily used for the dredge USS Sacramento, whose dredging activities were largely finished by the end of 1943. This increases the chances any unused diesel was left behind, in both stand-alone barrels and the larger tanks previously mentioned.

There were several salvage operations between 1944 and 1945, where equipment and materials were redistributed to military facilities elsewhere in the Pacific, but none mention fuel of any kind (especially fuel stored in the underground tanks). We know from cleanup projects undertaken by the Army Corps of Engineers and other groups in the 1980s and 90s, that at least some of the underground storage tanks and "barrel farms", still contained material, with indications it had been slowly leaking into the soil and lagoons since the 1940s.

### **Human Waste**

Based on Naval records, we know human waste was directed into the West and Central lagoons, where it was meant to flow out into the ocean through the channel. Using the averages below, we can arrive at an estimated amount of total waste, deposited into the lagoon during the Navy occupation:

**Average # of occupants** = 2000 or X (The average occupants number is based on various sources, where 1500 is the most common count of stationed personnel, over the course of the occupation)

**Average human waste per day** = 1lb or Y (general figure based on [this independent source](#))

**Elapsed Time:** = 1,095 days or Z (June, 1942 to June, 1945)

**Total Waste Created:**  $(X * Y) * Z = 2,190,000\text{lbs}$

### **Other materials**

A variety of other materials in smaller (though potentially significant) quantities, were used during the Naval Occupation, but obtaining quantitative numbers has proven difficult. The materials and their use are listed below for reference:

Name	Purpose
Freon-114 (Dichlorotetrafluoroethane)	Used in the refrigerating plant, which contained upwards of 14 separate condensing units
Fog Foam fire suppressant system	Installed at the piers for extinguishing shipboard fires
Lead based paint	All buildings, shelters, and equipment were painted with what is assumed to be lead based paints, and in the case of structures, the paint was mixed with sand or coral dredge to aid in camouflage

## Flooding of 1947 and 1958

By 1947, Palmyra was only manned by a small group of Navy and CAA personnel, who were almost evacuated in 1947 when high waves driven by a severe storm, raised the ocean level and began flooding out the main living quarters. Then in 1958, members of the IGY team stationed on the atoll survived another round of severe weather, which brought enough water and waves to leave the entire main runway submerged. We also know from scientists who visited Palmyra following the storms in 1958, that much of the roads and causeways restricting the flow of water in and out of the Eastern and Central lagoons (already weakened from the 1947 storm and a general lack of upkeep) were damaged or destroyed during the event, opening several areas back up to the ocean for the first time in 16 years.

While it is impossible to know how much material was disseminated into the lagoons during these events, we can assume any building materials, machines, debris, and anything else not secured or stored in water tight facilities (few of which were left), would have been washed out into the lagoons, likely settling in the Western lagoon, before possibly passing through the main channel out into the ocean.

## General Historical Mentions

### Part 2: 1948 - 1958

#### Visit by the USS LST 711

**Date:** June 15th, 1948

**Summary:** The LST 711 was dispatched as part of the Graves Registration cruise, to find the remains of those Marines left behind on islands throughout the Pacific during WW2. Palmyra was the first stop of the four initial discovery locations in the Pacific.

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#### *Excerpt from the Graves Registration Cruise Summary<sup>28</sup>*

...The average depth of the water inside is from 20 to 70 feet but just outside the reef it drops off from 1500 to 2700 fathoms...the diving detachment departed the ship to conduct an area search until dark. As the most of the islets have been attached by roads by our military forces during the war and are still intact but time and tide is slowly destroying these roads. Area search and sweeping operations were negative.

## The Palmyra Circle

**Date:** 1948 to 1949

**Summary:** The Palmyra Circle was a monthly newsletter produced by CAA employee's and their families, who lived and worked on Palmyra in the late 1940s.

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*October 30<sup>th</sup>, 1948 issue<sup>29</sup>*

Mr. Brunner...finally caught his big fish, a 61 pound ulua.

*May 21<sup>st</sup>, 1949 issue<sup>30</sup>*

Dr. David Bonnet, with Mr. Robert Mikuni, Mr. Keio Fukanaga and Miss Elsie Narikawa arrived on the NC 65 with a special spray outfit with which to spray the residential areas, dumping grounds, mess hall and hotel areas.

This spray is for a residual control of the common house fly. The spray remains on the walls for some time and continues to kill the flies for several month.

"The control of flies here is difficult, due to the abundance of breeding places. I would strongly recommend everyone take care of the basic sanitation for fly control in the vicinity of their own quarters," Doctor Bonnet says.

*June 4<sup>th</sup>, 1949 issue<sup>31</sup>*

A Fish with Two Names by Pauline Hong

Yes, there is such a fish with two names. It is called a Papio when young and Ulua when it gets to a size over 10 pounds.

Its body is diamond shaped, much compressed, snout short, eyes fairly large. There are several different species and each has different markings.

The Papio is always on the run and is a very interesting fish to catch.

Papio is frequently caught on the reef and is eaten by almost everyone here. Ulua is not caught as often but is the pride and joy of the person catches it. The biggest one caught here since I can remember weighed about 85 pounds. Who knows someone here may someday catch one that will be the world's largest.

...

Note to the Palmyra Fishermen and women. If you catch another of those 29 inch Lai, YELL! Jim says that the one Daisy Watson had last week was a world record, if it was that long and was a "Lai" NO FOOLING, let us know and we will send the information over to him.

*June 11<sup>th</sup>, 1949 issue<sup>32</sup>*

...fishing grounds of off Sand Island.

With the usual beginners luck, Mr. B managed to hook and land three papio averaging about six pounds. Five in all were caught by the party.

The biggest strike was made by Hoffman, who hooked onto Palmyra, but didn't land it.

In the afternoon another group went fishing in the same area and were fortunate enough to run through a school of ahi.

Again Mr. Brunner's luck paid off. He was the only one to land one of the big boys, (about 40 pounds) while the others suffered broken poles and lines. Mr. B's second strike resulted in disaster, as he too snapped his pole.

The afternoon catch was one Ahi, one barracuda, and six papio.

*June 18<sup>th</sup>, 1949<sup>33</sup>*

...Ed Howerton of the Powerhouse with usual powerhouse precision managed to keep everybody's head above water by hooking into a 14 inch Lai.

...the gang, not to be denied of their quota of fish went out and hooked into three 40 pound Ulua...Ed Howerton...hooking into the first 40 pounder.

The following evening Harry Dunn hooked into a 50 pounder that took four men to land.

*June 26<sup>th</sup>, 1949<sup>34</sup>*

The few people who have started gardens and kept them up are enjoying some fresh vegetables. The lettuce and tomatoes soon to be the best crops so far. However bell peppers and horse radish are being grown by the Redds. Marcel has some pumpkins growing behind the school house. Papaia trees will grow and bear provided they are in a sheltered place where the salt laden breezes will not hit them.

In the near future I plan to put out several lime and lemon trees also two grafted Mango trees and a grafted avocado tree when a suitable location can be found.

...

Omar is reported to have caught a tuna Saturday evening that is estimated to weigh around 100 pounds.

## **Vessels of the Pacific Ocean Fisheries Investigation (POFI)**

**Date:** 1948 to 1953

**Summary:** As part of the massive, US sponsored Pacific Ocean Fisheries Investigation (POFI), a group of vessels made regular trips to Palmyra and other islands, in an effort to evaluate Tuna populations and fishing potential in the Western Pacific. The research and conclusions were published across a variety of publications, as noted below.

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*Excerpt from an article in the Commercial Fisheries Review<sup>35</sup>*

Palmyra Island (western) lagoon was thoroughly prospected for bait on February 8 and 9 (1948).  
The only fish seen which might be used for bait was small mullet, which occurred in quantity  
along the beaches. There were apparently no fish of either the silverside or herring families here,

at least in any quantity. They were not seen during the day and they were not taken under a light at night.

*Excerpt from an article in Commercial Fisheries Review<sup>36</sup>*

On a survey trip to Palmyra by the author in June 1949, the entire island was scouted for bait. It was immediately obvious that fish of the size suitable for use as live bait were most plentiful in East Lagoon. These were primarily species of the mullet family (*Mugil crenilabis*, *M. vaigiensis*, and *M. trichilus*), varying from one inch to over 6 inches in length. The mullet occurs here in schools of varying size, from a few scoops to a hundred or more scoops, and could be seen swimming at the surface over the entire lagoon. Small milkfish (*Chanos chanos*), about 2 or 3 inches long, were also in evidence along the beaches. In West Lagoon, small goatfish, from one to 4 inches long, occurred in quantity along the north shore of the lagoon. According to several of the natives, the goatfish are fairly abundant along the sand beaches during June, July, and August...

In February 1949, the commercial tuna clipper Calistar prospected Palmyra Island for bait. Using a Galapagos net in the shallow waters of East Lagoon, only about 8 scoops of 5-inch mullet were taken. From discussions with Civil Aeronautics Administration (CAA) personnel stationed on the island it was learned that the small mullet, which, apparently, are most abundant during the summer months, were not in evidence during the Calistar's explorations in the early part of the year.

...

At Palmyra, another 15 tons of yellowfin were taken in the waters lying to the west of the Island. It may be of interest to note that the tuna were located by means of trolled lines. As the fish rose to the surface, chumming was begun. A number of tuna schools (possibly skipjack) was seen in the open ocean, but the fish were at all times moving too fast to permit fishing.

Interviews with CAA personnel stationed at Palmyra confirmed the fact that tuna are in evidence in the vicinity of the island the year round, and are frequently taken on troll lines within a short distance of the barrier reef along the west side of the Island.

*Excerpt from US Department of the Interior, Special Scientific Report<sup>37</sup>*

The Calistar was reported to have obtained only 8 scoops of bait-size mullet at Palmyra and the Oregon only 30 scoops of 6-inch mullet at Christmas Island. During the latter part of 1947 the Pioneer was reported to have caught 400 scoops of mullet at Palmyra and another 200 scoops at Christmas Island. The sampan Tradewind, fishing in the vicinity of the Line Islands during January and February of 1953, caught bait-size mullet as follows: 242 buckets at Palmyra, 85 buckets at Fanning Island, and 19 buckets at Christmas Island...Past experience has shown that the catchable bait at Palmyra Island is usually exhausted after only a few days of baiting.

...

The commercial tuna clipper Calistar, fishing in the vicinity of the Line Islands during February of 1949, caught approximately 50 tons of yellowfin at Fanning Island and another 15 tons of yellowfin at Palmyra Island. The Pioneer, during the latter part of 1947, caught 7 tons of yellowfin, mostly around Fanning and Christmas islands. During January and February of 1953 the Tradewind caught 7 tons of yellowfin at Palmyra Island and another 6-1/2 tons at Fanning Island.

*From the Trends and Developments section of the Commercial Fisheries Review<sup>38</sup>*

The Tradewind fished for tuna with live bait. Its Captain reports that bait (mostly mullet, *Mugil longimanus*) of suitable size for yellowfin fishing was scarce at Palmyra Island, but easily obtained at Christmas and Fanning islands. Surface schools of yellowfin tuna were small and scattered; no large concentrations were encountered, although more schools were observed in the Palmyra area than at the other islands.

About half of the 14 tons of yellowfin tuna was caught off Palmyra Island and half off Fanning Island.

## **Visit by the USCGC Buttonwood**

**Date:** April 13th, 1953

**Summary:** In the early 1950s, in response to the deaths of several Navy servicemen and civilians, the US government ordered an official investigation into the state of, and reasons for,

high levels of toxicity found in various fish species throughout the Pacific. The work was done entirely at Palmyra, found to be most representative of the conditions in the region.

PLEASE NOTE: There is some level of overlap between the first two sources, but the excerpts present primarily unique information from each.

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*Excerpts from a special report for the Office of Naval Research<sup>39</sup>*

Large numbers of red snapper were formerly shipped from Palmyra Island and sold in the Honolulu markets. Then in 1943 the first of a series of outbreaks were reported from eating Palmyra red snappers.

...

Palmyra was selected on the basis that it was an American possession and has been the center of a number of epidemics.

...

The turbidity of the water within the lagoon at Palmyra varies considerably depending upon the general climactic conditions at the time. However, for the most part the water within the lagoon is murky and undesirable for aqua-lung work. The best areas to work in were found to be at the western end of the atoll. The area immediately southwest of Sand Island was excellent for making underwater observations. The water temperature averaged about 28 degrees C.

Station #1:

It was in this area where the CGC Buttonwood anchored before unloading our equipment from the boat. The crew of the boat thoroughly covered this area by line fishing. Water depth was about 10 fathoms with probably a sandy bottom. The water was slightly murky. Small amounts of brown and green algae floated on the surface. Hooked Line fishing in this area yielded large numbers of red snappers and small sand sharks. Water temperature 28 degrees C

Station #2:

Shallow reef areas on West Lagoon side of Strawn Island. Reef and shore of coral sand and rocks. Some small, dead coral heads. No live coral observed. Green and brown algae along shore with slight growths on underwater rocks. Water temperature 28 C.

Station #3:

Shallow water passage way between ocean and east lagoon. Water depth one to four feet.  
Bottom predominantly of coral rocks and sand with some ooze. Steady current with changing tide. Large quantities of attached and floating green and brown algae.

Station #4: Off shore of small North of Sand Island. Shore of coral rocks, boulders and a small amount of sand. Small amount of algal growth. Bottom sandy at point of capture. Water temperature 28 C.

Station #5: Shallow reef area northwest of West Lagoon. Depth of water at mean high tide 2 to 4 feet. Bottom of sand and coral rock patches. Small amount of green and brown algae. Water temperature 29 C.

Station #6:

Shallow reef area on south side of Strawn Island. Conditions as in Station #5. Water temperature 32 C.

Station #7:

Tide pool on Strawn Island of approximately ten foot radius at low tide. Depth of water to three feet. Bottom of thick ooze. Very small amount of algae. Water temperature 32 C.

Station #8:

Reef shell southwest of Strawn Island. Depth of water 2 to 3 fathoms. Small amount of live coral and algae on edge of reef. Bottom sandy. Floating green and brown algae. Water temperature 28 C.

Station #9:

Reef area, western end of atoll. Water 2 to 6 feet deep. Many dead coral heads. Small amount of live coral. Small amounts of green and brown algae. Water temperature 28 C.

Station #10:

Boat house slip. Water 10 to 12 feet deep. Steel pilings and metal wreckage with algal growth.  
Bottom predominantly sand. Water temperature 28 C.

Station #11:

Shallow reef area north of Home Island, West Lagoon, 2 to 4 feet of water. A few small coral heads. Bottom sand and rocks. Small amount of green and brown algae. Water temperature 28 C.

Station #12:

Edge of shallow reef East of Home Island, West Lagoon. Depth of water 2 to 10 feet. Bottom of rocks with some sand. Slight growth of Algae. Shore of dead coral heads and boulders. Fairly strong current. Water temperature 27 C.

Station #13:

Northside of Strawn Island. Conditions similar to station 5 with 6 to 12 inches of water.

Station #14:

Northwest corner of Center Lagoon. Water depth 1 to 4 feet. Bottom of sand and ooze with scattered rocks and boulders. Some green and brown algae. Shore of sand and coral rocks. Water temperarture 28 C.

Station #15:

Reef edge in East Lagoon. 3 to 4 fathoms deep. Reef edge of coral boulders. Great deal of floating algae. Bottom of sand.

Station #16:

Near entrance of Center Lagoon. Water depth approximately 20 feet. Bottom of coral sand. Shore of sand and rocks. Slight growth of algae. Water very murky. Water temperature 28 C.

Station #17:

About 1 mile southwest of Sand Island. Depth about 7 fathoms. Bottom probably sand with scattered rocks. No obvious vegetation. Water temperature 28 C.

Station #18:

About 500 meters west of Sand Island in channel. Water depth 2 to 4 fathoms. Bottom of coral sand, boulders, and live coral. Water very clear. No obvious vegetation. Water temperature 28 C.

Station #19:

Shallow area near center of West Lagoon. Bottom of coral sand with some rocks. Water depth 2 to 3 fathoms. Water murky. No obvious plant growth. Water temperature 28 C.

Station #20:

Northern tip of Sand Island at old pier. Water depth to 15 feet. Bottom of sand with scattered rocks and boulders. Slight growth of brown and green algae. Water murky with some current. No live coral. Water temperature 28 C.

Station #21:

Coral shoal area, southwest of Sand Island. Depth of water to 20 feet. Bottom varies in different areas from sand with dead coral heads to complete covering of live coral. Small growth of algae. Concentrated population of fishes in various places. Water very clear except on outgoing tide when there is quite a strong current which brings murky water from lagoon. Conditions excellent for spearing and photography. Red snapper, parrotfish, eels, pompano and other reef fishers were abundant in this area. Water temperature 28 C.

Station #22:

Shallow reef area east of Papeli Island. Shore of sand, bottom of predominantly dead coral, slight growth of green and brown algae. Water depth 1 to 4 feet. Water temperature 28 C.

Station #23:

Shallow reef 100 meters east of Bird Island. Shore of dead coral. Bottom of coral sand with some heads of dead or live coral. Some growth of microscopic algae. Water temperature 28 C.

Fishes at Palmyra were abundant both in numbers and variety. Palmyra has the largest red snapper population of any area that we have studied thus far. The red snappers of Palmyra are notoriously toxic and the material collected should provide an adequate amount of the poison for future food chain studies. Three species of red snapper were found to be almost equally abundant: lutjanus bohar, L. vaigiensis and L. gibbus. The young of L. vaigiensis were exceedingly common in the lagoon but the adults were to be found only on the outside and especially at the western end of the atoll.

...Moray eels were plentiful but consisted largely of about three species: *Gymnothorax pictus*, *G. Javanicus* and what appeared to be *G. flavimarginatus*.

...Three species of puffers were observed: *Arothron hispidus*, *A. meleagris* and *A. nigropunctatus*. *Arothron hispidus* was very common, *A. meleagris* was only occasionally seen and only a single specimen of *A. nigropunctatus* was seen swimming in the shoal area at the west end of the atoll...not a single specimen of any of the sharp nosed puffers was observed during the entire trip.

...The parrotfishes are common and present in a great variety of species. Most of the parrots are considered to be edible by Mr. Otto Hornung, the resident agent at Palmyra, who claims to eat them whenever he gets the opportunity...The shoal reef area at the western end of the atoll provides excellent parrotfish collecting for night light spearfishing. *Acanthurus triostegus* and numerous other species of surgeon fishes were exceedingly abundant. Particular attention was directed towards obtaining a large collection of *A. triostegus* from various different ecological areas at Palmyra since this was the species which had caused the outbreak of ichthyosarcotosis at Maui, T.H., on February 28, 1951 which involved 28 persons. Moreover, the *A. triostegus* had been imported from Palmyra.

...There are at least two species of mullet, mugil app., which inhabit the lagoon. All of the mullet are said to be edible. Surmullet or goatfishes are common. *Mulloidichthys* app. are considered to be non-toxic but *Paruponsusa* app. must be held under suspicion until further studies have been completed.

...Ulua or pompano, *Caranx* app., are readily taken by trolling with spoons or feathers. The white ulua is commonly eaten and is a very fine food fish. However, the black ulua, probably *Caranx melampygus*, is considered to be toxic and reported to have caused a number of serious intoxications in the past...three or four small, and two large specimens of the dark species were observed swimming about 500 yards west of Sand Island.

...Groupers, *Serranus* app, *Cephalopholis argua*, etc, were common...Labrids did not appear to be very plentiful and only a few species were obtained.

Triggerfishes surprisingly enough were not present in large numbers, either in species or specimens. A few --- specimens of *Balistes flavimarginatus* were observed swimming in some of the shallow areas of the lagoon...Lethrinids were relatively common both in and outside of the lagoon...

Two excellent specimens of *Variola louti*, seabass, were taken by dynamite. Siganids were present but not abundant. Some centrids were present but not as abundant as in the Marianas. A fair series of *Abudefduf* app. were captured by spear and dynamite.

*Excerpts from special report on Palmyra marine algae<sup>40</sup>*

Field Station number A53-5. Shallow reef area northwest of West Lagoon, inside the barrier reef.  
Water at mean high tide 0.6 to 1.3 meters deep, clear; temperature 29° C.; bottom composed of  
sand and low-lying patches of dead coral; green and brown algae present but relatively sparse.

Field Station number A53-10. Boat house pier, an area littered with wreckage and steel pilings.  
Bottom predominantly of dead coral, sand, and mud; water 3 to 4 meters deep; temperature 28°  
C. The wreckage is covered with a heavy growth of minute algae. Acanthurids and young  
Lutjanus vaigiensis were particularly abundant in this area.

Field Station number A53-11. Shallow-water reef area north of Home Islet, West Lagoon.  
Bottom composed of sand and scattered coral knolls; water fairly clear, 0.6 to 1.3 meters deep;  
temperature 28° C. Larger algae present in small amount.

Field Station number A53-12. Area bordering shallow-water reef and dredged portion of West  
Lagoon north of Home Islet. The bottom drops off precipitously from the reef as the deeper  
portion of the lagoon is entered. Bottom of coral sand; water in the lagoon relatively murky;  
current moderate during tidal changes; temperature 27° C.; depth 6 to 8 meters; brown and green  
colored algae sparse and limited to the more shallow areas.

Field Station number A53-16. Near entrance to Center Lagoon. Bottom of coral sand; water  
murky; depth 6 to 8 meters; temperature 28° C. Large algae scarce.

Field Station number AS3-20. Northern tip of Sand Islet near old pier. Bottom of sand and coral  
rubble; water murky; depth up to about 6 meters; temperature 28° C.; larger brown and green  
colored algae sparse. Small sand sharks were frequent in this vicinity.

...

It is particularly notable, however, that only three species (of algae) of the twelve reported by Howe and Lyon (1916) have been recognized among the specimens of the new field collections. Even more striking is the large number of algal entities detected from the alimentary tracts of the several Palmyra fishes, which do not appear in the field collections.

The list of algae which follows includes all the sessile species detected to date in sufficient quantity or in satisfactory condition for preservation from the field collections at Palmyra Atoll.

Cyanophyta (Blue-green Algae)

Lyngbya conervoides  
Lyon's original determination verified.

Lyngbya majuscula  
One of the commonest plants in driftweed in April, 1953.

Lyngbya semiplena

Mixed with *L. majuscula*. The cells are 7 to 10  $\mu$  and 2 to 3  $\mu$  long. The trichomes have a thick, lamellate sheath and taper slightly at the tip.

*Lyngbya rivulariarum*

This tiny plant was attached to the mucous membrane of *Lyngbya confervoides* in the original Joseph Rock material. The trichomes are about 1  $\mu$  thick, sheathed by a thin, hyaline membrane. The cells are of the same thickness throughout, not attenuated at the top. The cells are 2.0 to 3.5  $\mu$  long, the apical cell rounded and without calyptora.

*Oscillatoria bonnemaisonii*

Entangled with *Ceramium* in drift, April.

*Phormidium penicillatum*

Small, lubricous masses in lagoon drift, April.

*Phormidium corium*

This was found in a tube among the original Joseph Rock collections. As has been indicated by Lindstedt (1943) as a result of laboratory culture studies, this plant does not differ from *P. papyraceum* Gomont. In the Palmyra material, the cells are slightly broader than is usual in this species, being 5 to 6 (7)  $\mu$  broad.

*Spirulina major*

This plant was rather frequent among filaments of *Symploca hydnoides* in the original Joseph Rock collection. The spirals in this plant are regular, a character which is supposed to distinguish it from *S. meneghiniana*, in which they are irregular. The many instances of intermediate conditions which are found, however, suggest that only one species is involved. The trichomes are about 1.0 to 1.5  $\mu$  thick.

*Symploca hydnoides*

The vial of old, faded material of Joseph Rock's collection from which Lyon identified *Lyngbya gracilis* seems to contain for the most part, *Symploca hydnoides*. This species forms long trichomes with thin sheaths and rounded apical cells which do not taper. The cells are usually 5 to 6 (7)  $\mu$  broad and 5 to 8  $\mu$  long. These specimens agree well with var. *genuina* as illustrated by Fremy (1933, p. 81). Since in this species certain trichomes possess the tendency to produce slightly constricted cells, thus recalling to a certain extent the habit of *Lyngbya gracilis*, it would seem probable that the filaments referred by Lyon to *L. gracilis* belong to this *Symploca*.

*Chroococcus turgidus*

Mixed with *Lyngbya semiplena*, April.

*Hormothamnion solutum*

Bornet & Flahault. Small masses mixed with other blue-greens in drift, April.

*Chlorophyta* (Green Algae)

*Phaeophila engleri*

Growing on and in dead shells, April.

*Enteromorpha clathrata*

The material of this plant collected by Joseph Rock in 1913 and now deposited in the Herbarium of the New York Botanical Garden, was determined by Howe as *E. plumosa* Kutzing. It represents a slender form of *E. clathrata* with many monosiphonous branches and corresponds with Bliding's "Typus II" (1944, p.335).

*Enteromorpha kylinii*

This material found in beach drift in April corresponds well vegetatively with Bliding's description: cells arranged in rows throughout, with two or more pyrenoids per cell, branched only at the base, the branches remaining simple.

*Rhizoclonium implexum*

The specimens at hand from beach drift, April, are apparently without branches and have filaments 30 to 45 (50)  $\mu$  in diameter.

*Cladophora* sp.

Our material is scant, consisting of a few tufts to 7 mm. high on a stolon of *Caulerpa*. The habit and cell form of the plant resemble closely that of *C. perpusilla*, but the filaments are somewhat coarser throughout, being mostly 100  $\mu$  in diameter in main branches and 55 to 70  $\mu$  in ultimate branchlets. More material is needed for verification of the occurrence at Palmyra Island of this species, recently reported by Dawson from both sides of the tropical north Pacific (Dawson 1954; 1954a).

*Cladophoropsis sundanensis*

The type material of *Cladophora sabulosa* Lyon has been re-examined and found, as Lyon had suggested, to agree with the genus *Cladophoropsis* both in morphology and in habit. Its filaments are mostly 125 to 135  $\mu$  in diameter in the outer parts of the mats, but may be 75  $\mu$  or less in diameter within. The septation and branching are highly irregular. Septae are formed more frequently in the peripheral filaments of the clump, while the cells of inner ones may be very long. In structure and dimensions the plant falls within the circumscription of *Cladophoropsis sundanensis* as given by Reinbold (1905, p. 147; 1913, p. 77, fig. 18). This species has been reported several times in recent years by Borgesen who records it from Mauritius and from west India. His specimens from Bombay most closely resemble the Palmyra plants. Recently Taylor has reported from the northern Marshall Islands a plant of similar size and habit which he refers to *Cladophoropsis zollingeri* (Kiitzing) Borgesen. He gives the diameter as ranging from 75 to 175  $\mu$  which, although somewhat exceeding the usual maximum diameter given for *C. sundanensis*, is never the less far from corresponding to the diameter range of *C. zollingeri*. Howe (1914, p. 31) in studying the Javanese type of *C. zollingeri* reports its filaments to be 215 to 315  $\mu$  in diameter and, thereby, closely related to the coarse *C. herpestica* (Montagne) Howe.

*Cladophoropsis* specimens which we have examined from the southern Marshall Islands and which are probably like Taylor's specimens, have filaments mostly 60 to 130  $\mu$  in diameter and are somewhat more laxly branched than the Palmyra material.

It is clear that a revision of *Cladophoropsis* is needed to clarify the circumscriptions of the now quite numerous species, but awaiting this it seems justified to reduce *Cladophora sabulosa* under the older name *Cladophoropsis sundanensis* with which it may most satisfactorily be united at this time.

This plant was said to be the only conspicuous alga in the summer of 1913, forming compact, spherical colonies 2 to 3 inches in diameter and rolling about freely in shallow water.

*Boodlea composita*

Apparently abundant in April at Station A53-22.

*Microdictyon pseudohapteron*

The few specimens at hand were found mixed with *Boodlea* and *Lynghya* in drift at Station A53-22 in April. They belong to Setchell's sub-generic category *Fibuliferae* and to his Section *Macrodictyon*. Of the four species recognized in that section, only *M. pseudohapteron* approaches the present plants in diameter of segments. Our specimens are small, mostly under 2 cm. in expanse, but appear to agree with the typical form despite somewhat lesser diameter of the segments, slightly smaller net mesh, and thicker walls (5 to 6  $\mu$ ). *M. pseudohapteron* was described from material dredged from depths of 20 to 46 fathoms in the western Indian Ocean. It has been reported by Okamura (1916) from the Ryukyu Islands and from Yap.

*Bryopsis pennata*

We here follow Egerod (1952), and Abbott, who in 1947 pointed out the confusion as to species limits in this genus. This species was apparently abundant both in January and April 1953.

*Caulerpa serrulata*

This plant was common at Station A53-5 and elsewhere in April 1953, with a range of forms represented. A small fragment of the original material, determined by Lyon as *C. freycinetii* var. *typica* f. *lata* Weber van Bosse, has been examined and found to agree with *forma spiralis* (Weber van Bosse) Gilbert of this species.

*Caulerpa urvilliana* var. *urvilliana* *forma tristicha*

A small bit of Lyon's original material has been re-examined and found to compare favorably with this species rather than *C. cupressoides* to which he referred it. As Taylor says (1950, p. 61) "This plant [in the northern Marshall Islands] takes the place usually occupied by *C. cupressoides* (Vahl) C. Ag. in the West Indies and when first seen in the field was mistaken for that species."

*Halimeda opuntia*

Rock's original specimen has been seen and the determination verified in accord with the species as interpreted by Taylor (1950).

*Halimeda discoidea*

The material of Rock's collection identified by Howe as *H. macroloba* Decaisne with qualifications has been re-examined. It seems to correspond with *H. discoidea* as reported by Taylor (1950) from Bikini.

*Dictyosphaeria cavernosa*

The species now known under this name was recognized by Lyon as *D. favulosa*. The original specimen was seen.

*Rhipilia geppii*

Specimens determined by M. S. Doty were provided from the King collection of January 1953.

*Phaeophyta* (Brown Algae)

*Sphacelaria furcigera*

Found epiphytic on the vesicles of *Turbinaria* in April and producing an abundance of plurilocular fruit-ing bodies in addition to a few propagulae.

*Turbinaria trialata*

These plants found at Station A53-5 in April, correspond with specimens from Guam and Saipan and with the plant figured by Taylor (1950, pi. 53, f. 2) as *T. ornata* from Bikini.

*Rhodophyta* (Red Algae)

*Asterocystis ornata*

A small amount of this species on a slide was prepared from the King collections, identified by M. S. Doty, and deposited in the Bishop Museum.

*Acrochaetium robustum*

Epiphytic on vesicles of *Turbinaria* in April.

*Cruoriopsis mexicana*

The present material was found as a greenish crust about 150  $\mu$  thick on dead pieces of coral collected in April. It agrees in all essential details with the Mexican species (Dawson 1953, p. 99, pi. 10, figs. 11-14), including size of hypothallus cells, rhizoids, shape of vegetative filaments, shape, division and pedicellation of tetrasporangia, etc. The tetrasporangia tend to be somewhat smaller than in the type, usually not exceeding 60 g, in length. In as much as the type came from north latitude 32°, this represents the first record from the tropical north Pacific. The species is

amply distinct on several counts from the Indonesian *C. dezwaanii* Weber Van Bosse and *C. reinboldii* Weber van Bosse.

*Porolithon marshallense*

Several of the original plants identified by Howe as *Lithophyllum craspedium* forma abbreviation Foslie have been examined. They are very similar in form and structure to Taylor's Bikini plants, although the branches average somewhat thicker. Taylor has discussed the synonymy of this species, earlier known under varietal names.

*Porolithon gardneri* forma *subhemispherica*

The plant examined by Howe and identified in 1916 as *Lithophyllum kaiserii* Heyd. var. ? appears to correspond with Taylor's (1950) interpretation of *Porolithon gardneri*, as illustrated in his plate 70, fig. 1.

*Goniolithon frutescens*

The original Rock specimens identified by Howe appear to be placed correctly here.

*Jania decussato-dichotoma*

Collected by King in January.

*Jania tenella*

Best developed as an epiphyte on *Turbinaria* at Station A53-5 in April.

*Jania capillacea*

Harvey. Mixed in driftweed at Station A53-5, April.

*Ceramium masonii*

The material found mixed in driftweed at Station A53-5 in April is sterile, but compares well with Mexican examples of this species. Dawson (1950) has pointed out supposed reproductive distinctions from *C. gracillimum* var. *byssoideum* (Harvey) G. Mazoyer, but continued study of central Pacific material now suggests that these may not be real.

*Centroceras clavulatum*

The material found mixed in driftweed includes filaments corresponding with var. *inermis* (Kutzing) Piccone.

*Excerpts from Poisonous and Venomous Marine Animals of the World<sup>41</sup>*

Surveys conducted during April and May 1953 by Halstead and his associates at Palmyra Island revealed that large masses of *Lyngbya* were conspicuously growing on the warm inner parts of the broad reef flats. The filaments of *Lyngbya*, not having a holdfast, become entangled in other algae, coral, rubble, and sand. As the filaments proliferate and increase in length the strands are frequently broken up, become matted, and are carried to shore by waves.

It was observed that Lyngbya was particularly abundant at the east end of the island where large numbers of surgeonfishes *Acanthurus* app. were feeding on it. Since previous toxicological surveys and epidemiological reports had indicated an unusually large ciguotoxic fish population at Palmyra Island, it was decided to collect samples of some of the more dominant kinds of algae and to test them for toxicity.

The samples consisted of *L. majuscula*, *Boodlea composita* (Harvey), *Turbinaria ornata* (Agardh), *Caulerpa serrulata* (Forsk&l), *Bryopsis pennata* var. *secunda* (Harvey), *Jania capillacea* Harvey, *Jania tenella* Kutzing, *Ceramium mansonii* Dawson, *Enteromorpha* sp---, *Homothamnion solutum* Bornet and Flahault, and *Centroceras clavulatum* (Agardh).

The results of this study were reported by Habekost al. (1955). The blue-green alga *L. majuscula* were of particular interest because of toxic substances that had been reported in other species of freshwater Cyanophyta (Fitch et al., 1934; Deem and Thorp, 1939; Steyn, 1943; Wheeler, Lackey, and Schott, 1942; Ingram, 1953; Vinberg, 1954; Ingram and Prescott, 1954; and others). Aqueous homogenized extracts were prepared and injected intraperitoneally into white mice. It was found that all the algal extracts were moderately toxic to mice; i.e., one or more of the mice injected died within a period of 36 hours, with the exceptions of *Enteromorpha* and *Hormothamnion* which were only weakly toxic.

...

It is of further significance that in a series of eight reef fishes taken in the immediate vicinity and at the same time where the Palmyra algae had been collected, all the fishes were toxic as follows: strongly toxic (one species, *Arothron hispidus*), moderately toxic (five species, *Acanthurus fuliginosus*, *Chaetodon auriga*, *Abudefduf septembifasciatus*), and weakly toxic (two specimens, *Acanthurus fuliginosus*, *Abudefduf sordidus*). Moreover, specimens of *Lyngbya majuscula*, *B. pennata* var. *secunda*, and *Caulerpa serrulata* were found in the intestinal contents of these fishes.

## **Study of the Development Potential of Palmyra**

**Date:** September, 1953

**Summary:** This survey was led by retail developer and then manager of the Halekulani Hotel, Richard Kimball. He and a group of experts in a variety of fields flew to Palmyra, where a detailed study of its potential for commercial purposes, especially as a recreational facility, was undertaken.

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*Excerpt from the Development Study report<sup>42</sup>*

...there are such pest insects as mosquitos, flies, and small black ants, common to most areas throughout the world, and in the usual quantities. Rats have been reported on the island but none were observed on the September trip.

## Reef Fishes Toxicity Study

**Date:** October, 1958

**Summary:** A group of scientists, sponsored by Loma Linda University, visited Palmyra to expand their study on the toxicity of reef fishes. They were joined by E. Yale Dawson, who did extensive research of the physical changes to Palmyra and how it impacted Palmyra's environment.

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### *Excerpt from journal article on historical physical changes at Palmyra<sup>43</sup>*

...Fish poisoning, of the ciguatera type, was first observed in the Line Islands, of which Palmyra is the northernmost, about 1943. Prior to that time ciguatera-producing fishes were unknown there (Halstead and Schall, 1958). All available evidence seems to indicate that ciguatera-producing fishes become toxic as a result of their food habits. Apparently, environmental changes affecting these food habits have taken place in the Line Islands and have given rise to a toxic cycle in reef fishes. This cycle is believed to originate with certain kinds of marine plants.

...

The original algal vegetation of the lagoons is known only from the remarks by Rock that 'The two species of Halimeda [H. discoidea and H. opuntia] grow on the edge of the lagoon between coral.' Nevertheless, the presence of these conspicuous large forms among coral indicate that an appreciable flora must have existed in keeping with that of other coral atoll areas. This is now virtually absent. The closing of the inter-island reef channels in 1941 effectively destroyed the natural circulation of water and killed the sessile inhabitants of the lagoons, both coral and algae. Today, in much of the murky, semi-stagnant water only a few blue-green algae grow, together with green, shell and coral borers and small amounts of such tolerant green algae as Enteromorpha. However, in East Lagoon, which now has regained a portion of its connection with the sea through two openings across the reef, a limited flora consisting largely of

Gelidiopsis occurs with a few patches of Codium. These seem to represent the first large forms to return and to begin the reconstitution of a lagoon flora as the trend to natural circulation develops.

...

Porolithon oncodes and P. craspedium were collected near the end of Penguin Spit off Home Island on the upper parts of coral mounds in 5 to 10 foot depths, and may be expected to occur prominently on the reef edge.

...

The following observations are arranged according to the field collection stations occupied and are accompanied by the writer's field numbers representing those specimens collected and prepared for deposition in the Herbarium of the University of California, Berkeley.

#### Local Field Stations

##### **19521-19523. Shallow lagoon reef-flat midway between Kaula Island and Cooper Island, October 18.**

A scanty flora occurs in this highly modified, almost sterile area. It consists only of a little Jania and Wurdemannia. It would appear that most of the western lagoon flats can boast of little more varied floras than this. Observations along this lagoon opposite the west end of Cooper Island off the old NATS Terminal showed essentially barren, murky conditions. Except for some green boring algae and very scant, dwarfish, filamentous greens, nothing was seen. The area along this lagoon opposite the south end of Strawn Island is also essentially barren. Only a poor, sparse growth of Lyngbya was observed.

##### **19537-19540. Inshore side of the western reef-flat about half a mile north of Sand Island, October 18.**

The flora here consisted almost entirely of Turbinaria with a heavy epiphytic cover of Acrochaetium, Lophosiphonia, Polysiphonia, etc.

##### **19558-19560. At a depth of 5 feet northwest of the northeast end of Sand Island, October 18.**

The flora here, on brilliantly illuminated white sand bottoms, consisted largely of Pocockiella and dwarfish Pterocladia on dead coral fragments.

Annotated List of the Present Benthic Marine Plants as Observed and Collected in October, 1958

*Ceramium*

*Gelidiella bornetii*

*Turbinaria trialata*

*Acrochaetium gracile*

The filaments are about 7 /x in diameter, tapering to 4.5 p. These are seemingly like specimens reported from Eniwetok, up to 2 mm. tall.

*Ceramium marshallense*

These are mostly slender forms with lower axes only about 80-90 g in diameter and usually with elongating internodes suggesting *C. equisetoides* Daws. The tiered arrangement of the terminal, tetrasporangial segments and the strongly circinate tips of young branches, seem, however, to substantiate placement here.

*Polysiphonia* sp

the scar cells are regularly placed when observable at all, and commonly in a 14 spiral above, pericentral cells 4.

*Lophosiphonia*

in mixture with *Ceramium* and other *Lophosiphonia* sp.

*Pocockiella variegata*

*Ceramium serpens*

...conditions throughout a large part of the feeding area of fishes on the vast reef flats and in the lagoons have been markedly changed by man's activity, and that in most of these areas the development of *Lyngbya majuscula* has been favored. This alga is now present as pure stands or as mixtures in almost all assemblages of plants in the shallower waters and was observed to be eaten indiscriminately in mixtures of various algae by such common reef fishes as *Acanthurus triostegus*. Such tests as have been made on this alga have indicated that it may show toxic properties when injected intraperitoneally into mice (Habekost, Fraser & Halstead, 1955).

Further- more, the recent outbreak of "swimmer's itch" in Hawaii, caused by *Lyngbya majuscula*, has demonstrated highly toxic qualities in this alga even when placed in contact with the skin of human beings (personal communication from Dr. George W. Chu, University of Hawaii). These observations, as well as the recognition of fragments of Lyngbya in a large majority of gut samples of poisonous fishes from Palmyra Atoll (Dawson, Aleem & Halstead, 1955) place this alga under strong suspicion as a contributor to the incidence of

ichthyosarcotoxicism in the Palmyra region. This suspicion is further supported by the fact that ciguatera-producing fishes were not observed at Palmyra until 1943 at which time the major physical modifications causing disruption of the natural flora and fauna had been inflicted. These disturbances and the creation of conditions favoring the large-scale increase of Lyngbya throughout the region may have been effected not only by the dredging, filling and other construction activities, but also by the introduction into the waters of polluting wastes from a population of several thousand human beings. It is well known that Lyngbya majuscula has a broad tolerance for such conditions as high water temperature, high organic content, low salinity and high turbidity.

After the above was written a paper by J. E. Randall (1958) was received which presents somewhat similar conclusions from a general worldwide review of ciguatera. He says: “The basic poisonous organism is benthic, . . . most likely a blue-green alga.” He points out that in many areas, especially in the Line Islands, the incidence of poison fishes has been associated with military activities involving dredging, blasting and general disturbance of the natural substrate.



## Appendix

### List of Fauna

The following list collects all Fauna (and algae) mentioned throughout the entries in the *General Historical Mentions* section. They are organized by entry, and, where possible, identified by additional information provided in the original text. Every effort has been made to correctly spell and transcribe the latin names, while providing good readability, but errors may still exist, for which I apologize. Some of the entry's Latin designations may be out of date or no longer in use, but for posterity sake are formatted to match the original entry.

#### Brothers (1810)

"black type" of Beach la mar	Turtle
------------------------------	--------

#### Fairy (1848)

Rich black mould (algae)	Green Turtle
Sharks	

#### Louisa (1862)

Beach la mar (sea cucumber)
-----------------------------

#### USS Portsmouth (1873)

Cuttlefish	Fiddler crab
Crustacea (18 species)	Small land crab
Echini (7 species)	Large land crab
Asteria (starfish) - (solaster)	Tetrodon implusus
Holothurian (Sea Cucumber) - five species)	Pseudoscaeus jonesi
Mollusca (mollusks)	Chaetodon sordidus
Coral (ten species)	Glyphisodon sordidus
Sula - (one type of booby, two types of gannet)	Muraena picta
Sooty Terns - (two species)	Gymnothorax pictus
Buttonbird - (unknown shearwater species)	Murcenophis pantherina

Frigate bird (Man of war hawk)	Muraena variegata
Curlew	Muraena lita
Golden Backed Plover	Muraena pfeifferi
Tropicbird (Phaethon)	Sidera pfeifferi
Small lizards	Sidera pantherine
Hermit crab (soldier crab)	

CR Bishop (1893)

Sharks
--------

Ebon (1893)

Boatswain (bird)	Rays
Boobies	Sharks
Turtles (gigantic)	Coconut Crabs

Concord (1909)

Sharks	Land crabs
Sea birds	

USS West Virginia (1912)

Snipe	Boatswain
Curlew	"Black birds with short bills and white spots"

Luka (1913)

Boobies	Mullet
Terns	Ulua
Sharks	Houmea
Crabs	Moi
Hermit crab	Uhu
Coconut crab	

Sanyo Maru (1920)

Ulua	Sharks
Ama-ama	Birds
Uhu (bluefish)	Eel

Mengs (1920)

Sharks	Mullet
Balloon fish (puffer)	Black conger eel

Eagle 40 (1921)

Red snapper	Love birds
Ulua	Boobies
Tern	Frigate
Curlew	Shellfish

Sampan Palmyra (1922)

Sharks	Hawaiian Salmon
Great ahi (yellow-fin tuna)	Ma-ni-ni (conviet fish)
Ulua	Giant yellow eel
Ono	Ha pu-a-pu-u

Sampan Lanikai (1935)

Ulua	Ono
Tuna	Hawaiian Salmon
Shark	Mullet
Red snapper	Awa

Palmyra Circle (1948-49)

Ulua	Lai
Papio	

POFI (1948-1953)

Mullet	Goatfish
Mugil crenilabis	Yellowfin

<i>M. vaigiensi</i>	Tuna
<i>M. trichilus</i>	<i>Mugil longimanus</i>
<i>Chanos chanos</i>	

Buttonwood (1953)

Sand sharks	<i>Jania capillacea</i>
Parrotfish	<i>Jania tenella</i>
Eels	<i>Ceramium mansoni</i>
Pompano	<i>Enteromorpha</i>
"reef fishes"	<i>Homothamnion solutum</i>
<i>Lutjanus bohar</i>	<i>Centroceras clavulatum</i>
Red snapper	<i>Cyanophyta (Blue-green Algae)</i>
<i>L. vaigiensis</i>	<i>Lyngbya confervoides</i>
<i>L. gibbus</i>	<i>Lyngbya majuscula</i>
Moray	<i>Lyngbya semiplena</i>
<i>Gymnothorax pictus</i>	<i>Lyngbya rivulariarum</i>
<i>G. Javanicus</i>	<i>Oscillatoria bonnemaisonii</i>
<i>G. flavimarginatus</i>	<i>Phormidium penicillatum</i>
Puffer	<i>Phormidium corium</i>
<i>Arothron hispidus</i>	<i>Spirulina major</i>
<i>A. meleagris</i>	<i>Symploca hydnoides</i>
<i>A. nigropunctatus.</i>	<i>Chroococcus turgidus</i>
Parrotfish	<i>Hormothamnion solutum</i>
Surgeon	<i>Chlorophyta (Green Algae)</i>
<i>Acanthurus triostegus</i>	<i>Phaeophila engleri</i>
Surmullet	<i>Enteromorpha clathrata</i>
Goatfish	<i>Enteromorpha kylinii</i>
Ulua	<i>Rhizoclonium implexum</i>
Pompano	<i>Cladophora</i>
<i>Mulloidichthys app</i>	<i>Cladophoropsis sundanensis</i>
<i>Paruponsusa app</i>	<i>Boedlea composita</i>
<i>Caranx app</i>	<i>Microdictyon pseudohapteron</i>
<i>Caranx melampygus</i>	<i>Bryopsis pennata</i>
<i>Serranus app</i>	<i>Caulerpa serrulata</i>
<i>Cephalopholis argua</i>	<i>Caulerpa urvilliana var. urvilliana forma tristicha</i>
Labrid	<i>Halimeda opuntia</i>
Triggerfish	<i>Halimeda discoidea</i>
<i>Balistes flavimarginatus</i>	<i>Dictyosphaeria cavernosa</i>

Lethrinids	Rhipilia geppii
Variola louti	Phaeophyta (Brown Algae)
Seabass	Sphaelaria furcigera
Siganids centrids	Turbinaria trialata
Abudefduf app	Rhodophyta (Red Algae)
Arothron hispidus	Asterocystis ornata
Acanthurus fuliginosus	Acrochaetium robustum
Chaetodon auriga	Cruoriopsis mexicana
Abudefduf septembefasciatus	Porolithon marshallense
Acanthurus fuliginosus	Porolithon gardneri forma subhemispherica
Abudejduf sordidus	Goniolithon frutescens
Lyngbya	Jania decussato-dichotoma
L. majuscula	Jania tenella
Boodea composita	Jania capillacea
Turbinaria ornata	Ceramium masonii
Caulerpa serrulata	Centroceras clavulatum
Bryopsis pennata var. secunda	

#### Reef Fishes Toxicity (1958)

Gelidiopsis	Ceramium marshallense
Codium	Polysiphonia sp
Porolithon oncodes	Lophosiphonia
P. craspedium	Pocockiella variegata
Ceramium	Ceramium serpens
Gelidiella bornetii	Lyngbya majuscula
Turbinaria trialata	Acanthurus triostegus
Acrochaetium gracile	

## Ulua Weights and Mentions

The following chart shows any mention of Ulua's in the historical mention sections, and their corresponding weights (if recorded).

<u>Source</u>	<u>Year</u>	<u>Weight (lbs)</u>
Luka	1913	n/a
Sanyo Maru	1920	n/a
Eagle 40	1921	133
Eagle 40	1921	70 to 130
Sampan Palmyra	1922	~100
Sampan Palmyra	1922	30
Sampan Lanikai	1935	30
Palmyra Circle	1948-1949	85
Palmyra Circle	1948-1949	61
Palmyra Circle	1948-1949	40
Palmyra Circle	1948-1949	40
Palmyra Circle	1948-1949	40
Buttonwood	1953	n/a

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